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THE PANAMA CANAL: THE DUAL VERSUS THE SINGLE-LAKE PROJECT.

By Gen. Henry L. Abbot. With reply by George S. Morison.

General Abbot and Mr. Morison are not only engineers of pre-eminent distinction and international reputation, but the leading advocates of the two great projects for the Isthmian Canal. The following papers are supplementary to their more extended discussion of the question in this Magazine for December, 1902, and January, 1903. They are brief summaries of the essential points of the respective plans. It is unnecessary to do more by way of introduction than to call attention to the interest and importance of this finished debate by two of the world's highest authorities.—THE EDITORS.

IN Mr. Morison's paper which appeared in the January number of THE ENGINEERING MAGAZINE, and in a second which is printed in the proceedings of the American Society of Civil Engineers for the same month, he proposes to modify radically the plan adopted by the Isthmian Canal Commission, of which he was a member, not only in the mode of construction of the Bohio dam but also by abandoning about six miles of canal now largely excavated, below Bohio, and adopting a new location, much of it raised above the general level of the country, and involving three crossings of the bed of the Chagres river as well as an additional lock at Tiger Hill. It would seem therefore that there are three plans for the canal to be considered, which in order of date are: that of the International Commission of Engineers, known as the *Comité Technique*, that of the Isthmian Canal Commission, and that of Mr. Morison. The fundamental difference between them consists in the fact that by the first the regulation of the Chagres river is effected by two lakes, one of them created by a dam at Alhajuela and the other by a dam at Bohio, while by the other two plans only one lake is projected, at Bohio, but which is much larger

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and at a much higher level. The Isthmian Canal Commission and Mr. Morison both admit that the upper lake may ultimately be required for low-water supply, but propose to defer its construction.

Since Mr. Morison has misapprehended the action of the New Company when he states that it "rejected" the plan, advocated in my paper, in THE ENGINEERING MAGAZINE of last December, in favor of a plan with a higher summit level involving the construction of a feeder line from Lake Alhajuela, it seems desirable to explain the conditions more fully.

In preparing the project for a private company the *Comité Technique* was in duty bound to consider with the greatest care the element of cost. Many plans with different summit levels were prepared and carefully studied to develop the facts. The deeper the cut at the Culebra the greater would be the chance of accidental delays involving heavy interest payments, so near the completion of the work. It was hoped and believed that the low-level plan as defined in my paper could be completed in about the same time as the group of works at Bohio, and at practically the same cost as the plan at a higher level to which Mr. Morison referred, but as it was regarded as certain that this condition could be fulfilled with the latter, it was formally approved, but with the understanding that if no unexpected delays occurred the low-level project should be preferred; and all details were carefully arranged to permit the final decision to be deferred for several years without involving any loss of work already executed. Mr. Morison therefore does me too much honor in attributing a preference for this plan to me personally. It was the plan which the Company hoped and believed could be executed within the estimated cost. The conclusion was unanimous that without delays the two plans would involve about the same outlay, and I will add that it is my personal belief that the same will be true for a single or dual lake project even with the increased dimensions now contemplated to accommodate larger shipping. The following is a more detailed explanation of this low-level project of the Company.

The summit level is that of Lake Bohio, of which the highest stage above mean tide is fixed at 20.50 metres (67.3 feet), the medium stage at about 63 feet and the lowest stage at 18.75 metres (61.5 feet). For the lake projected by the Isthmian Canal Commission, and adopted by Mr. Morison, these heights are 92 feet, 85 feet, and 82 feet. It remains to consider what these heights imply.

It must be borne in mind that the topography of the country fixes the least height possible for a single lake, called upon to regulate the floods of the Chagres and to receive and store the supply needed to

meet the demands of the canal in the low-water season. This height is about that adopted by the Isthmian Canal Commission, which at normal stages is about 22 feet above that projected by the *Comité Technique*. There are three grave objections to this increase.

The first is that it adds 22 feet to the height through which each ship that passes the canal must be raised and lowered. If, as generally admitted, a canal without locks is preferable to one requiring them, it follows that the addition of 33 per cent. to the height of the summit level is a distinct demerit. Furthermore, if the construction of the upper lake is to be contemplated ultimately, when it will be too late to correct this evil, why not avoid a permanent defect by making the lake a part of the original project?

The second objection is that the locality at Bohio is not well suited to receive more than two locks in flight, and this has led to the certainly objectionable lifts, ranging from 41 feet to 46 feet, (usually 42.5 feet, according to the stage of the lake as adopted by the Canal Commission. Mr. Morison reduces them by introducing a new canal level and an additional lock at Tiger Hill. Why not avoid the difficulty by lowering the level of the lake as is done by the *Comité Technique?* Such lifts with their enormous lower gates (83 or 84 feet high) are quite without precedent in a ship canal, and would certainly largely increase the risks of accidental delays, and even of interruption of traffic. By the project of the Company the lifts would range between 34 feet and 31 feet according to the stage of the lake, the usual being less than 32 feet.

The third objection to a single-lake project arises from the nature of the sub-strata at the site of the Bohio dam. This is a gorge probably due to the action of some ancient river, which has been filled up to the level of the present bed by tertiary deposits of clay, gravel, and sand. The dam projected by the engineers of the Company was of earth resting upon a solid bed of clay and sand that offered a suitable foundation. The borings indicated deep under-lying strata of gravel and sand which might permit percolation to a certain extent but, it was believed, not sufficiently to endanger a dam exposed to the moderate head contemplated. Such percolation would exert no influence upon the supply reserved for the needs of the canal in the dry season, since this would be held back in the upper lake above Alhajuela where no escape is to be apprehended. By the single-lake project the conditions are radically changed. About 22 feet are added to the usual head of water, and the security of the reserve held in Lake Bohio for the dry season is endangered by percolation not easily estimated. Hence the Isthmian Canal Commission considered a masonry core extending

to bed rock to be essential, adding enormously to the difficulty of construction and to the cost. Mr. Morison, by making use of recent data concerning sand filtration, arrives at an encouraging estimate of the volume of this percolation, but it would seem that he has overlooked the fact* that this permeable stratum lying far below the foundations of the dam, and extending an unknown distance into the region below, cannot be assumed to be affected by raising the water level below the dam, as he proposes to do by his additional higher canal level extending to his lock at Tiger Hill. Such raising would doubtless reduce seepage through the dam itself, but this is not what is to be feared. So long as the deep route for the water to filter to the sea below the foundation of the dam exists, the needed reserve is liable to escape. It would seem to be much the better plan to store it among the hills where it is certain to be safe, and thus avoid the necessity of adding 22 feet to the head acting upon these sub-strata.

But these three difficulties do not complete the objections to the single-lake project. The two-lake plan regulates the entire river from the point where it reaches the route for shipping to the sea. With a single lake, the first few miles, where hills contract the waterway, are exposed to the full force of the floods, and of the frequent freshets which during eight months of the year average two or three per month. The extension of the level of the lake nearly to Alhajuela would have little influence, for the volume unreduced must reach the wide lake, and as the upper part of the submerged district would be very shallow the chief flow would be confined to the deepest portion, which is the route followed by shipping. It is true that this extension of lake surface nearly to Alhajuela would do much to prevent the introduction of a small volume of silt into the ship channel; but the exclusion of the silt, and of sand and gravel rolled along the bottom as well, will be better effected by transforming the torrential river into a quiet stream of practically uniform flow, as would be done by the upper lake with its outflow regulated as contemplated.

Mr. Morison introduces another point, upon which I touched lightly in my paper, because it is independent of the question of whether one or two lakes shall be preferred. Reference is made to the mode of regulating the outflow of Lake Bohio.

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* The language in Mr. Morison's article in THE ENGINEERING MAGAZINE may perhaps make this checking of deep percolation by raising the water level below the dam appear to be a forced construction of his meaning, but in his article in the Proceedings of the Society of Civil Engineers he reduces the seepage as computed in his paper on the Bohio dam from 40 cubic feet per second to 28 cubic feet, due to a reduction of head from 90 feet to 60 feet; and I think therefore I rightly understand his idea, although it is not easy to see why both heights should not be considerably increased.

The Isthmian Canal Commission provides for automatic regulation, allowing the flow to pass over a fixed spillway 2,000 feet in length. It estimates that with 5 feet on the crest about 78,000 cubic feet per second will escape, and with 7.5 feet about 140,000, and that the latter will more than meet all demands.

The *Comité Technique* preferred the system of regulated outflow that has proved to be an entire success on the Manchester Ship Canal. The weir crest would be fixed at about a metre (3.3 feet) below the normal level of the lake. Counterpoised gates operated independently would permit the outflow to be easily and rapidly regulated. To secure a uniform outflow never exceeding 1,200 cubic metres (42,380 cubic feet) a length of crest of about 144 metres (472 feet) would be required, based on a largest flood discharge of the river at Bohio of 2,640 cubic metres (93,236 feet) per second for 48 hours, the two lakes co-operating. While an automatic system of controlling the overflow is undeniably the more simple it contemplates a constantly increasing discharge during a flood, and leaves the maximum volume to be determined by the maximum height of flow over the crest. With a system of movable gates this discharge admits of regulation to a uniform and safe volume during the entire period, an important matter when the capacity of the channel below is limited, as is the case below the Bohio dam. The duty of the operator here involves no real difficulty, since he has only to watch the level of the water in the lake and below and be guided accordingly. Under ordinary conditions the automatic system would probably meet all needs, but in floods the results would be more doubtful. The details of the plans of the Commission for protecting the lower districts, including the canal and railroad, against inundation are not yet published, but as damages to the railroad have usually occurred at such times the matter was carefully investigated by the *Comité Technique,* and the conclusion was reached that overflow should be restricted to 1,200 cubic metres, per second (42,380 cubic feet). The automatic-regulation plan admits a volume estimated at 80,000 cubic feet or more to pass in floods. The introduction of a new canal level 26 feet above tide would suggest that Mr. Morison has doubts on the subject. The substitution of a system of movable sluice gates would equally effect the object, and probably at much less cost. Furthermore, the two systems admit of combination.

The only merits which are claimed for the higher level incident to Lake Bohio in the single lake project appear to be: (1) a saving of expense in the deep cut through the Continental divide, which as appears above cannot be established without a complete technical discussion including the reduced costs at Bohio and all other items in-

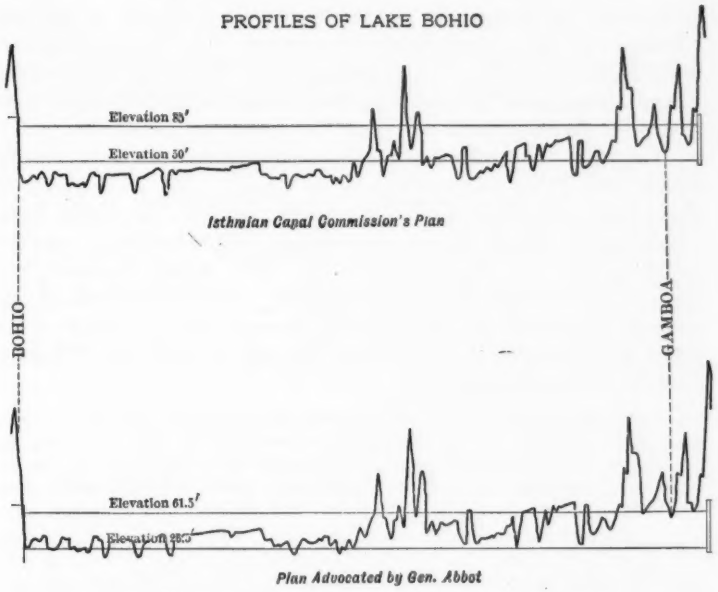
volved; (2) the reduction in the volume of silt carried by the river to the route traversed by shipping, which as has been shown above is better effected by an upper lake; and (3) the increased area of Lake Bohio (about 40 square miles) affording a more convenient basin for the accommodation of shipping in transit. In answer to this latter claim it may be stated that the lake as projected by the *Comité Technique* (about 23.5 square miles in extent) would afford all the space needful for this purpose, and it would appear that there is little advantage in increasing by 70 per cent. the evaporation, and hence enlarging the volume required for canal reserves during the dry season. The greater portion of the added area would be shallow and much of it would soon be invaded by tropical growth.

In fine, then, the dual-lake project regulates the Chagres throughout the entire valley, giving a canal absolutely free from currents or silt and sand deposits, and at a considerably lower summit level than is possible when a single lake is called on to do the work. By it the difficulties of construction of the Bohio dam are greatly reduced, and the objectionable lifts at that locality are brought within the limits of experience. The low-water reserve is secured beyond cavil. It is interesting to note that all the technical objections raised against the Panama route by hostile witnesses at the hearings of the Senate Committee on Interoceanic Canals, in 1902, prior to the passage of the Spooner Act, have more or less force as against a single-lake project, but fail utterly as against the dual plan.

THE ADVANTAGES OF LAKE BOHIO AT THE HIGHER LEVEL.

By George S. Morison.

BECAUSE a canal without locks is preferable to one requiring them, it does not follow that an addition of one-third to the height of a summit level is a distinct demerit. When locks are once adopted the whole system of canal is altered. The limiting dimensions of the locks are imposed on commerce. The canal is changed from a salt-water to a fresh-water canal. A summit level is established and a water supply must be maintained for this summit level. While a tide-level canal may be preferred to a canal with a summit level, the summit level is not without its advantages, and when a summit level is adopted, that plan should be selected which is the best possible plan for a canal with a summit level—not that which most nearly approaches a tide-level canal. The plan which Gen. Abbot refers to and which, though set aside, would undoubtedly have been



LAKE BOHIO, ON THE SINGLE-LAKE AND DUAL-LAKE PLANS.

preferred by the *Comité Technique,* except for the additional time which it was feared its construction would involve, required three locks on the Pacific side and two on the Atlantic. The plan adopted by the Isthmian Canal Commission required the same number of locks, although those on the Atlantic side were given an excessive lift which the writer thinks it would be wise to avoid. The time required to pass the extra lock does not appear of material importance. The time required to pass through the canal will be a matter of convenience of meeting points more than of close calculations of speed. As many vessels as possible will meet in Lake Bohio, and under any plan it will take longer to pass from Panama Bay to Lake Bohio than from Colon Harbor to Lake Bohio. The advantages of the lake at the higher level are the increased area, the increased depth through a large portion of it, and the increase of cross section through the narrow portion between San Pablo and Gamboa, this increase being ample to provide for the additional flood discharge which may be expected if no water is stored above Alhajuela. The accompanying profiles, on which the normal elevations of the water in the lake under the two plans and bottom levels 35 feet below these elevations are given, show that there would

be a restricted channel for practically the whole length of the lake advocated by Gen. Abbot, while there is very little restricted channel at the higher elevation. The advantage of the higher lake will become even more manifest by comparing these profiles with the map on page 506 in the January number of THE ENGINEERING MAGAZINE.

The other point relates to possible seepage from the lake. In this matter Gen. Abbot refers to a paper by myself in the Transactions of the American Society of Civil Engineers, entitled The Bohio Dam, which paper contains an estimate of the possible maximum seepage which might pass under this dam. Gen. Abbot, however, has missed the meaning of those calculations. The calculation of the seepage was based entirely on seepage through "the permeable strata below the foundations of the dam," as appears from the following quotation from this paper:

> "Either dam proposed would itself be practically impervious. The puddle wall in the last design may be considered entirely so, and the filling generally would consist of water-tight earth, loose sand and gravel being excluded. * * * * The distance between the up-stream slope * * and the down-stream slope * * is 2,400 feet in a straight line; the actual distance which water must travel to pass between these points is at least ½ mile. To this should be added the distance from the dam to the place above, where the geological channel may connect with the present river; this distance is not accurately known, but it can hardly be less than ½ mile; in calculating the seepage, however, it has been entirely neglected, and the distance which water must travel through a bed of sand and gravel has been assumed to be 2,500 feet."

It makes no difference where the water goes, whether it passes out to the sea by some remote course or rises through the bottom of the Chagres at some lower point, the amount of seepage is directly as the head and inversely as the distance, and the calculations given in that paper assumed maximum conditions. The conclusions were such that the writer feels that this whole question of seepage is of so little importance that it has no real bearing on the height of the dam. Furthermore, this seepage would be through sand and gravel which would gradually be silted up with the finer material brought down by floods. It would be greatest when the work was first completed. On the other hand, although the Alhejuela Dam would be founded on rock and be an excellent structure, the country above is a limestone country, and not only are fissures in limestone rocks the most treacherous causes of leakage, but the constant tendency is for them to enlarge.

THE PROMOTION OF INDUSTRIAL EFFICIENCY AND NATIONAL PROSPERITY.

By John B. C. Kershaw.

The past few years have been marked by an almost phenomenal advance in the introduction of labour-saving machinery and methods. But, as Mr. Kershaw says, "a machine without a skilled worker determined to obtain from it the highest possible yield, can effect little in the reduction of the cost of manufacture." That is his theme—how to increase the productive capacity of the worker and make him willing to use it to the utmost. There is no more important question now before the industrial world.—THE EDITORS.

> "The more closely capital and labour are associated for mutual advantage the better. For labour to hamper capital is ruinous. For capital to starve labour is disastrous, even to capital, for labour in the concrete constitutes the mass of consumers. If work-people cannot buy, consumption must fall to a minimum."

THE above extract from an article on "American Competition," contributed by Mr. George Howell, F.S.S., to one of the leading British engineering weeklies in 1899, forms a fitting introduction to the present series of articles on the "Promotion of Efficiency in Industry."

It is generally admitted by all competent observers, that the struggle of the three leading manufacturing countries of the world, namely, Germany, the United Kingdom, and the United States—for supremacy in the world's markets, will grow keener with each succeeding year. The extent to which Britain has lost, or is now losing, ground in this struggle is debatable, and widely different views are held concerning the alleged loss of position.* Even those who assert that the loss on the part of the United Kingdom is largely imaginary, agree that the *future* with respect to the maintenance of British industry and commerce is not without anxiety, and everyone admits that to retain the industrial position won by British manufacturers during the century which has just closed will require the best energies and the utilisation of every possible help. Even Sir Alfred Bateman, the compiler

* See articles in *The Nineteenth Century*, May, 1902, and *The Monthly Review*, June, 1902; also Board of Trade memorandum upon Trade of the United Kingdom, Germany, and United States, 1902, p. 30.

of the Board of Trade report just referred to, is slightly pessimistic in his views regarding the future.

One of the chief factors in lessening the cost of production of manufactured articles is the increased speed of output which follows the use of machinery in the hands of highly skilled workers, whose chief aim is to obtain the maximum of output per normal working day. In the past, English manufacturers and workers have been slow to recognise the importance of this factor, while the rapid advance of the United States as a manufacturing country has been largely due to the recognition of this connection between rapidity of manufacture and low cost, and to the introduction and use of machinery in every possible case.

Machinery of the latest design, however, is now being introduced into British industries, and British manufacturers can no longer be reproached with their supineness in this matter. A machine, however, without a skilled worker determined to obtain from it the highest possible yield, can effect little in the reduction of the cost of manufacture of the particular article produced, and it is questionable whether British industries have yet attained the latter condition of success.

The writer of the series of articles entitled "The Crisis in British Industry," which appeared in *The Times* towards the end of 1901, certainly proved that in most of the industries carried on in the United Kingdom there is decided room for improvement in the efficiency of labour. It is not necessary to devote space in the present series of articles to a consideration of the question whether this state of affairs is due to the "ca'canny" teaching of trades-union leaders, or whether it is the result of other causes. Such a discussion is outside the scope of this inquiry, which deals with the methods and systems at present in use in Germany, England, and the United States, for obtaining that active co-operation between capital and labour which is now absolutely essential for the maintenance of position as a manufacturing country.

Methods:—In Germany the movement has been in the direction of reform in the social condition of the workers, rather than towards high wages and bonus systems. In most of the larger German engineering works we find elaborate arrangements and organisations for the comfort of the workers during working hours. The State system of insurance against sickness, accident, and old age, also assists in ameliorating the lot of the German worker, and renders him content with longer hours of work and with lower wages than those customary in the United Kingdom and America.

As an example of the sanitary and other conveniences for increasing the comfort of the workers in Germany, we may take the arrangements at the machinery works of Ludwig Loewe & Co., in Berlin. The factory buildings are well-lighted, and well-ventilated, and are warmed by hot air during the colder months of the year. The men as they enter and leave the works pass through a washing and wardrobe room, where each is provided with a numbered cupboard for his working and outdoor clothes. These cupboards are thoroughly inspected by a sanitary officer once a fortnight, and are so designed that it is impossible for dirt to accumulate either above or below them. The washing places consist of long troughs placed between the rows of cupboards, and as the men leave work water is turned on in order to provide a running stream through these troughs. In winter, the water is heated. The floor of this room is of cement, and it can therefore be thoroughly cleansed when necessary by aid of a hose pipe and a stream of water. Messrs. Loewe claim no philanthropic motive in providing these facilities for cleanliness and comfort. They say that to consider the well-being of their employees is a wise policy, simply from a selfish point of view. Their men are reported to be of superior appearance, and it is stated that few are to be seen leaving the works in a dirty or untidy condition.

A second example of modern German methods of promoting the efficiency of labour is to be found in the electrical engineering works of the famous Nuremberg firm, Schuckert & Co. In addition to its obligatory contributions to the sick and accident funds, the firm contributes largely to pension funds for the aged, widows, and orphans, these funds having been started by a gift of £40,000 from the heads of the firm. The contributions to these funds by the workers are made on the following basis: members of the staff (i. e., all in receipt of monthly salaries) contribute 4 per cent. of their salaries. All sums contributed in this way are refunded without interest, if the member concerned should leave the firm. After five years, any member invalided is entitled to a pension equal to 10 per cent. of his last year's salary, and this pension is increased 2 per cent. for every additional year's service, until a maximum of 70 per cent. of the salary is arrived at. In case of death, the widow draws for the rest of her life half of the sum due to her husband, and for every child, an addition to this of one-tenth is made. All men in receipt of weekly wages are enrolled as members of their own pension fund after five years' service; and they are not expected to contribute towards the fund. When invalided they are entitled to receive £1 per month, with 1 shilling extra

for every further year of service above five. The maximum pension is reached with 50 shillings per month. The firm also encourages the men to insure their lives in ordinary life assurance societies, and special terms have been obtained for employees of the Schuckert Company. Profit-sharing has also been instituted at the Nuremberg works, according to a writer in *Engineering*, on the following basis:

> "All employees, of whatever rank, share in the business profits after one year's service. The gratifications have, in the case of the men, varied between 4 shillings and 300 shillings per year. The firm invests these small sums in the municipal savings bank when desired to do so, and when such an account has reached the amount of £25, the sum is transferred to the business capital of the firm; the ordinary shareholder's dividends are then allowed. A workman's share of this kind is limited to £100."

As regards other agencies for improving the condition of the workers, a co-operative supply association on the cash principle was started early in 1896. Beer and other light refreshments can be obtained *in the works*, and the profits of the canteen flow directly into the mens' pension fund without any deduction. In 1896 they amounted to £700. Special training schools for mechanics and clerks are carried on by the firm, and baths for the men and members of the staff have also been built at the cost of the Schuckert Company. A large evening continuation school for the children of the employees, has been built by Mrs. Schuckert at a cost of £15,000. In this school the boys receive special instruction in drawing, and the girls in domestic subjects. In concluding a description of this works, a writer in *Engineering* says:

> "We shall hardly commit a mistake when we ascribe part of the success of the E. A. G. to this policy of making every employee take a direct interest in the affairs of the firm, and offering him reasonable inducement to stay with the company."

The recent financial troubles of the Schuckert Co. are to be ascribed to unwise company promoting on the part of the managing directors, and not to any defects in the works organisation.

At the German Niles Tool Works—a manufactory recently established near Berlin at a cost of £300,000, in order to produce the American types of machine tools—from 1,200 to 1,500 men are now employed, although manufacturing operations were only commenced in December, 1899. Speaking of the sanitary and social features of this modern works, *Engineering* says:—

> "The men's welfare, protection, and comfort, have received the most careful and effectual attention. The grass plots and trees on the site and between the buildings may strike the manufacturing engineer accustomed to crowded yards and rooms as a little odd. But order and

> neatness are as desirable outside as inside, and tidiness throughout is a better testimonial to efficient management and supervision than that appearance of ever-busy activity which leaves no time for clearing up."

The washing and locker arrangements resemble those in the works of Ludwig Loewe & Co. (described above) with this improvement, that each man is provided with an enamelled wash basin, each basin being numbered to agree with the locker facing it. Clean warm water for washing purposes is provided all the year round. A bathroom adjoins the wash and locker room, and is provided with twenty separate bathing cells. Each man in the firm's employ is allowed half-an-hour once a week, for the use of these baths, and *no deduction* is made from his pay for this loss of time. A ticket system is used to enable each man to have a bath once in seven days, and the twenty bathing rooms suffice to allow 1,860 men to use them per week, between the hours of 8 and 7. The firm also provides a well-arranged dining hall for the use of the men, with gas stoves for cooking the meals brought by the men themselves or by their families. A canteen is provided in the works, and sandwiches, tea, coffee, and beer, may be taken into the shops for consumption during working hours. This canteen is managed by the firm and profits flow into the men's pension fund. A well-appointed surgery is also provided in the works, a certificated male nurse being in charge of this department.

The arrangements for promoting the physical and social comfort of the workers at these three works may be taken as typical of the larger German engineering establishments, and no practical purpose would be served by multiplying similar examples of the German methods of obtaining co-operation between employers and employed. Mr. Barnes, the Secretary of the Amalgamated Society of Engineers, broadened his mental horizon in 1899 by making a tour of German engineering works, and his report contains the following remarks:

> "The general protection of workmen and provision for their comfort, is much more complete than in this country, and the shops are more spacious and cleanly.....Another common feature is the modern appearance of most workshops, and the use of first-class appliances. Everywhere new factories are building, machinery is being put down, and a great deal of that at work is dated this year or last. A no less marked feature common to German workshop life is the leisurely manner in which the men go about their work. Although piece work is common, I saw nowhere any bustle. With one exception, in all the shops visited men smoked during working hours, and in most of them there were canteens or other provision for getting refreshments while at work."

In 1901 the members of the English Institution of Electrical Engineers made a similar tour in Germany, and all those who took part

in this were loud in their praises of the sanitary and social organisation of the works they visited.

Even in the matter of protection for the workers in dangerous trades, in which it might be supposed that Britain led the way, it is questionable whether manufacturers are not more hampered by restrictions in the Fatherland. The following extract from the *Zeitschrift für Elektrocheinie* shows the regulations in force in the manufacture of lead secondary cells, an industry which is much more extended on the continent than in the United Kingdom:

> 1. No work connected with the manufacture of lead or its compounds shall be permitted in ordinary living or sleeping rooms.
>
> 2. The rooms or work places must be kept as clean as possible, and must be well ventilated. The floors must be washed daily, or swept after sprinkling with water.
>
> 3. Washing places must be provided for the workers, in addition to suitable accommodation for storing and changing their ordinary clothing.
>
> 4. Special clothing must be provided and worn by the workers during working hours.
>
> 5. Tobacco smoking and chewing must not be permitted during working hours.
>
> 6. Food and drink must not be stored or partaken of in the working rooms.
>
> 7. Meals must be eaten in a separate room, completely separated from those in which manufacture is carried on. Before eating, the workers must change their clothes, wash their faces and hands with hot water and soap, and rinse out their mouths with clean water. These precautions are also to be carried out when leaving the factory at night.
>
> 8. A periodic medical examination of the workers must also be made, and those found to be suffering from lead poisoning, or from any disease predisposing thereto, are to be excluded from the factory until restored to health.
>
> The special dangers of the work must be explained to all applicants, before permitting them to start work in the factory.

In the United Kingdom, the majority of works and factories are still conducted on the *"laisser faire"* principles of the Manchester school of economists. The teaching of this school results in paying the worker the smallest possible wage, and in making none but the legally necessary provisions for his social or physical comfort. Under these conditions of employment, the usual relation between employers and employed is one of antagonism. The conversion of private firms into joint-stock companies in recent years has still further tended to widen the breach between capital and labour.* The directors of a few

* See *The Fortnightly Review*, May, 1900, "Joint Stock Enterprise and Manufacturing Industries," by John B. C. Kershaw.

of the larger and better managed works have, it is true, recognised the unwisdom of treating their employees rather worse than their machines, and have instituted social and other agencies for the amelioration of the life of the workers. In these cases, the agencies are on the same lines as those found in Germany. Systems of profit sharing, and other schemes for the social or educational advancement of the worker, are, however, exceptional in English works and factories. The larger number of instances given, as compared with those for German and American works, is simply due to the greater ease with which details can be obtained, concerning the movements that are in progress in my own country. Perhaps the most modern examples of enlightened treatment of workpeople in Britain are to be found at Port Sunlight and Bournville. At the former place Messrs. Lever Bros., Ltd., have erected a model village for the housing of their work people, the houses being let to tenants at rentals which, in view of the accommodation, compare favourably with those asked for ordinary working-class property. A striking feature of these "cottages" is that they are built in semi-detached blocks; each cottage contains a bath, and is provided with a fair sized garden. The soap factory at Port Sunlight was erected in 1889, and the employees are now said to number 3,000. The village comprises six hundred houses, and four miles of roadways, widening out at each junction into open spaces. A schoolhouse for five hundred children, mens' and girls' club houses, a public kitchen and public hall, have been erected, and a park, bowling green, and cricket ground have been laid out and presented to the village,—all these institutions being built or founded at the firm's expense.

The reasons which have induced this firm to build houses, rather than to distribute cash to their employees, are fairly* stated in the following extract from a speech recently delivered by the chairman of the company:—

> "In order to produce fine men and women it was absolutely essential that the children must be brought up from childhood in healthy and beautiful surroundings, for nothing else would so help and elevate them. If they took a working man and put him in a back slum at the east end of London, his children would grow up under conditions which choked and stifled every human impulse of their nature, and he felt that from what they were doing at Port Sunlight the children would receive greater benefit than could possibly accrue to them by the distribution of money to their parents, however liberal that distribution might be."

* Writing on April 4, 1901, the secretary of the company informed me that the receipts from the cottages have not sufficed to balance the expenditure upon rates and maintenance, and that on January 1st, 1901, the rents were raised 9 pence to 1 shilling 9 pence per week, according to the size and style of the cottage occupied.

The Bournville scheme, founded in connection with the works of Cadbury & Sons near Birmingham, is on somewhat similar lines. The estate which Mr. Cadbury has vested in trustees at Bournville covers about 330 acres, and with the cottages erected on it, is valued at between £170,000 and £180,000. Nearly one-half of the three hundred and seventy cottages on the estate have been sold at cost price to the tenants, 2½ per cent. and 3 per cent. being charged for the money loaned to complete these purchases. The remaining cottages and shops are let to weekly tenants, and the rents of these and the ground rents for the whole estate are paid into the funds of the trust. There are in addition two hundred allotments, and gardening classes also cultivate portions of the estate, under the Worcestershire County Council. The total rent roll is £5,246 per annum, and the surplus after deducting maintenance charges, is to be devoted to the development of this and other estates. This is the feature which distinguishes the Bournville scheme from those worked at Saltaire and Port Sunlight, and takes it out of the category of purely business speculations. Mr. Cadbury has stipulated that in any future estate purchased and developed under his trust deed, only 1/15 of the ground shall be covered by factories; and that the buildings for the workers shall only occupy ¼ of the land on which they are erected. The remainder of the estate is to be preserved as open land for the benefit of the inhabitants.

A large number of other firms in the United Kingdom carry on profit-sharing schemes of diverse character, the amount distributed to the work people being in the form of a lump sum based on the profits in the previous year. In some cases a definite percentage on the annual wages is granted; in other cases the owner of the works decides for each individual worker.

As an example of the latter, the profit-sharing scheme of Mr. J. P. Hartley at Fazakerley near Liverpool may be noticed. At this works the profit-sharing scheme was initiated in 1885. A certain percentage of the profits is set aside each year for distribution amongst the employees, four-fifths of whom are women and girls. The rates of wages paid are rather above the standard rates of the district. The participants receive their share in cash personally from the owner, at an annual Christmas gathering. The sum received varies, and is based partly upon the wages, and partly upon the thoroughness of each individual's work in the preceding year. The total amount distributed in this way in sixteen years has been nearly £29,000. In the year 1900, £3,140 was distributed to 690 employees, the majority of whom were women and girls.

As an example of profit sharing based on a fixed percentage of the profit and wages, the scheme in operation at the confectionery works of Messrs. Clark, Nickolls & Coombs in East London may be described. The number of employees is, in this case, between 1,500 and 1,600. The profit-sharing scheme was inaugurated in 1890. One-half of the profits, after payment of 6 per cent. on the ordinary share capital, are set aside each year as a bonus fund. A portion of this bonus is paid over to the employees in cash; the remainder is invested as a provident fund, from which payments are made in cases of sickness, marriage, or death. A superannuation fund has also been started by this firm. In the period 1890-1900, £45,025 was distributed to the workers under the scheme. In the latter year, the bonus amounted to £9,500, on a wages list of £60,000, and the number of participants was 1,224.

Similar schemes are in operation at the works of the South London Gas Company, and of the Thames Ship-Building Company. The former company employ on the average of 3,000 work people, and in the period of 1890-1900 the large sum of £126,283 was distributed under the scheme, to the regular workers. The company have now appointed two working men directors to the board, as the value of the company's stock held by the workers is over £53,000, the average holding being £46 per man.

The Thames Ship-Building Company have worked their profit-sharing scheme since 1893, and in the eight years ending in 1900 they have distributed £63,911 to their workers, an amount equal to 4 per cent. on the wages. The managing director of this Company has stated that the scheme, "has helped to improve the relations between the Company and its employees, and is slowly but surely convincing the latter that their interests are the same as those of their employers."

The old-age pension scheme of Messrs. Colman of Norwich is an example of another method of promoting co-operation between the employers and employed. According to *"Commercial Intelligence"* of September 1899:—

> "Messrs. Colman propose to provide at their own expense a pension of 8 shillings a week for all their employees who shall be in their employment at the age of 65, and who have given evidence of their willingness to increase the proposed pension by a contribution of their own. To put this disposition of self-help to the test it is stipulated that all members who join the pension fund will be called upon to pay a mimimum sum of 2 pence a week.
>
> "The whole of these weekly payments, with compound interest at 3 per

> cent., which the company guarantees, will then go towards increasing the 8-shilling pension of the firm to some larger sum which will depend upon the precise contribution of the men. Should a workman leave the service of the company, or die before he reaches 65, all his contributions, plus the 3 per cent. compound interest, will either be returned to him or be placed to the benefit of his widow or heirs."

At the ship-building yard of Messrs. Denny & Co., at Dumbarton, a somewhat novel system of rewards is in operation.

The men employed at this works are asked to write down and bring to the notice of their chiefs, ideas for improving the machinery or processes in use; and if adopted their ideas are paid for. In the five years 1894-1898, one hundred and thirty-four men claimed payments under this scheme, and £181 was distributed to eighty of these claimants. In some cases the ideas led to patents being applied for and granted.

As final examples of English methods, the schemes of Messrs. Furness, Withy & Co., of Hartlepool, and of Messrs. Armstrong, Whitworth & Co. of Newcastle, may be briefly referred to. According to the *Times* of July 14 last, Sir Christopher Furness announced at the annual meeting of the former company that:—

> "The directors have decided to increase the ordinary share capital by 500,000 ordinary shares, with the view of inducing workmen connected with the establishment to take shares. The chairman said that he was prepared to advance to them at the rate of 3½ per cent. the amount they required to enable them to become shareholders. The dividend declared was 10 per cent., together with a bonus of 10 per cent. on the ordinary share capital."

Messrs. Armstrong, Whitworth & Co. inaugurated their profit-sharing scheme in 1897. All employees and officials of the company are urged to become shareholders, and 4 per cent. is paid on the sums invested, plus a bonus increasing with the dividend declared upon the ordinary share capital. The limit of invested capital for an employee is fixed at £200. On June 30th last, the amount deposited by the participators in the profit-sharing scheme reached a total of £139,474, and the number of individual depositors was between 2,500 and 2,600. These figures were kindly supplied to me by the secretary of the company for the puropes of this article.

American Methods.—In the United States we find, as one would expect in the country which has done the most to develop the use of machinery in all industries, elaborate arrangements for obtaining the co-operation of the workers. In some few instances these take the

form of social agencies, but in the majority of instances a bonus or premium system based on a high normal level of wages is employed, and every man is allowed free scope for individual effort and ability. The comparative feebleness of trade unionism in the States has undoubtedly facilitated the introduction of this system of allowing each man a free hand, and of paying him exactly what he can earn. Whether the conditions which have favoured its introduction will continue, is doubtful, in view of the spread of militant unionism in the States. For the present the system is wonderfully effective. Various systems of bonus payment are in use, to act as incentives to large and rapid output, and a description of one of these will therefore serve to cover the methods employed at a large number of American works.

The Bethlehem Steel Company has adopted a system, which was described by Mr. H. L. Gantt in a paper read before the American Society of Mechanical Engineers in 1901. For all the larger pieces of work put into the shops, a chart is prepared showing the best methods of performing each operation, and the minimum time requisite. The sum of these times is the standard time required to complete the job under normal conditions of work. The man in charge of the work is paid a fixed day wage, and in addition a bonus or premium depending upon the saving in time with which he completes the particular work in hand. The co-operation of foremen and under managers in the working of this system is obtained, by paying them a bonus, increasing with the number of men under them who earn premiums on their weekly work.

The system is said to have worked admirably in the shops of the Bethlehem Steel Company, and since its introduction the output of the machine shop has been doubled, without any increase in the number of men employed.

This system is only a modification of that described by Mr. F. A. Halsey, in a pamphlet on "Premium Systems of Payment in Workshops," published in 1899. The system described by Mr. Halsey was in use at that time in American works, and consisted in fixing a standard time in hours for each particular piece of work, and in paying to the worker one-third of the saving in cost effected by any reduction upon this standard. The system was said to work well, provided that the standard was not fixed too low. As compared with profit-sharing, it was claimed that the worker benefitted *at once* from his industry instead of having to wait six to twelve months for his reward. A further advantage claimed was that the lazy and incompetent did not share in the gain, whereas in the usual schemes of profit-sharing

no attempt was made to discriminate between the two classes of workers.

With regard to the general effects of the premium system, an English engineer states in *The Times* issue of December 3, 1901:—

> "While in Pittsburg, I went closely into the working of this system in one of the largest and most important electrical engineering establishments in the world. In the actual week's wages sheets which I inspected there were over a thousand men who had earned premiums. The premiums varied from 25 per cent. to about 100 per cent., over the wages, and an examination of almost the whole of the premium tickets revealed the fact that the vast majority of those who had earned high premiums were English workmen from the Manchester and Sheffield districts."

As to other methods of bonus payment, the United States Steel Corporation is introducing a somewhat similar system for obtaining active co-operation from its foremen, managers, and departmental heads.

According to Mr. Schwab, the managing director of all the steel plants under the combine, every foreman and departmental head employed by the corporation is to be given a percentage of the profits—paid to him in cash—in addition to his fixed salary. The recipients will be free to utilise this bonus payment as they please, but facilities will be given for investing it in the stock of the corporation. This system dates from January 1st, 1902, and has now been extended to all classes of workers employed by the Steel Trust. On January 8, 1903, it was announced that 12,000 employees had become shareholders in the company and had subscribed for £416,000 of stock.

The *Electrical Review* of New York states that the American Steel and Wire Co. are instituting a pension department, which will provide pensions for old and faithful employees, in accordance with their years of service. It is reported that this company, which employ between 25,000 and 30,000 men, will provide the whole of the funds required for this pension scheme, without the aid of any contributions from the men themselves. This scheme was to come into operation on January 1, 1902.

On account of the wide-spread adoption of bonus and premium systems of payment in the United States there is considerably less activity in the promotion of social schemes and agencies for the benefit of the workers than in England and Germany. The following details of the organisations at two works, however, show that America is not entirely without examples of enlightened treatment of workpeople, apart from the pecuniary rewards of labour.

The National Cash Register Co. of Dayton, Ohio, maintains a large number of social and educational agencies for the benefit of its work-people. This firm employs a large number of women and girls, and they state that by giving these workers chairs with high backs and foot rests, in place of uncomfortable stools, they obtain more work in 7¾ hours than was formerly obtained in 10. Lifts have also been provided, to save the physical strength of the women and girls, and coffee and other refreshments can be obtained in the factory at cost price. A hall where physical exercises are indulged in by the employees morning and afternoon, baths which can be used during working hours without deduction of pay, a dining hall, a free dispensary, a library, a "rest" room, and a dancing school, have all been erected, and are worked at the firm's expense. According to Mr. J. H. Patterson, the president of the company, the result has been "to show that kindness pays," and the advantages and benefits conferred upon the work people are said to have been abundantly repaid.*

Another example of this kind is offered by the pickle factory of H. J. Heinz & Co., at Pittsburg. This works gives employment to about 2,000 work people, and the main factory covers 13 acres of floor space. Separate dressing and cloak rooms are provided for the men and women workers, and each woman is provided with a locker, and a neat working dress. Baths and dining halls are provided for each sex. A circulating library has been formed in connection with the dining hall, and this is said to be largely used by the women employees. Refreshments are supplied in the factory at cost price, under the management of the firm. The entertainment of the workers is provided for, by two roof gardens, where they may spend a portion of the mid-day interval, and at times hold receptions of their friends. A large concert hall, seating 1,500 people, has also been erected. In this hall concerts and dramatic performances are given, and an amateur dramatic society, a choral society, and a brass band, all draw their members from the employees of the firm.

The following paper will take up the hindrances which have heretofore existed to the development of the best efficiency in British industry, and a suggested modification of the bonus system which, it is believed, will be of great advantage.

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* The National Cash Register Co. has been involved recently in a dispute with its employees, but the dispute is reported to have been settled upon mutually satisfactory terms.

POWER AND PUMPING STATIONS OF THE NEW ORLEANS DRAINAGE SYSTEM.

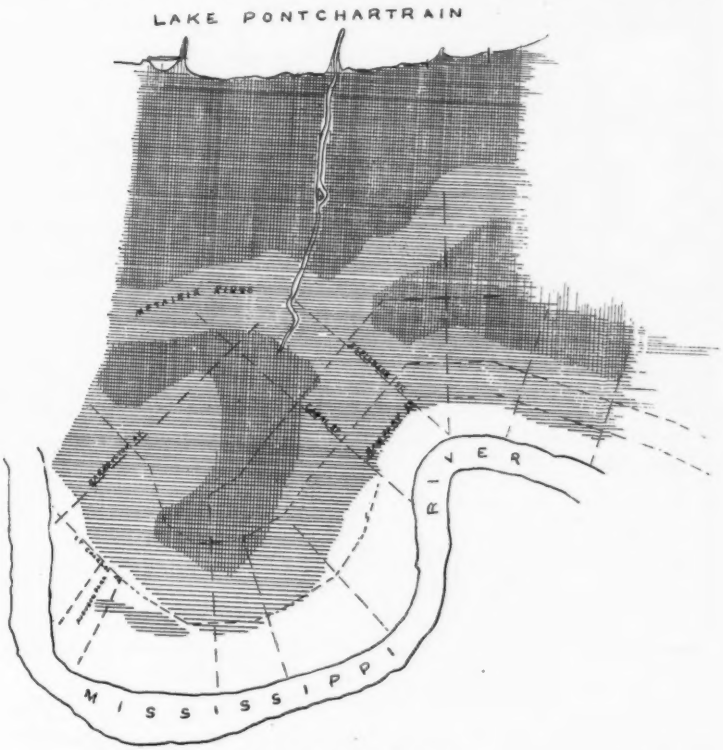
By William Mayo Venable.

The installations described by Mr. Venable are interesting not only in themselves and in the examples of practice and apparatus they embody, but further than that in the instance they afford of the co-operation of several branches of the engineering profession to accomplish a single result. In New Orleans, as in some of the cities of the Low Countries of Europe, the civil and the municipal engineer have had to call in their mechanical and electrical brethren to provide the solution of the problems of city drainage. In this light the system is especially noteworthy and instructive.—THE EDITORS.

THE city of New Orleans, like most of the land at each side of the Mississippi River in the alluvial country, lies considerably below the high-water line of the Mississippi River. The whole city would be inundated by the river occasionally if it were not protected by a levee along the river front. The city is also protected by levees running at right angles to the river, one above the city and one below it, and also by a levee along the shore of Lake Pontchartrain and by levees along the banks of the various canals which reach from that lake into the territory of the municipality. New Orleans is so near to the mouth of the river that the land upon which the city is built is not only lower than the high-water stage of the river, but is in part lower than the level of the Gulf of Mexico and of the various lakes in the vicinity of the city. Therefore there is no natural drainage for the land enclosed by the levees surrounding the town. The rain water that falls upon this area has to be pumped, so as to force it to flow into either Lake Pontchartrain or Lake Borgne. The city itself covers a large area, although the major part of its area is not built up as a city. The part at present chiefly occupied by buildings consists of a strip a mile or so wide along the bank of the river.

It has long been recognized as extremely desirable to drain properly all parts of the city between the river and Lake Pontchartrain and this work was actually undertaken some years ago, and four and one-half million dollars have been spent upon the drainage system, which is

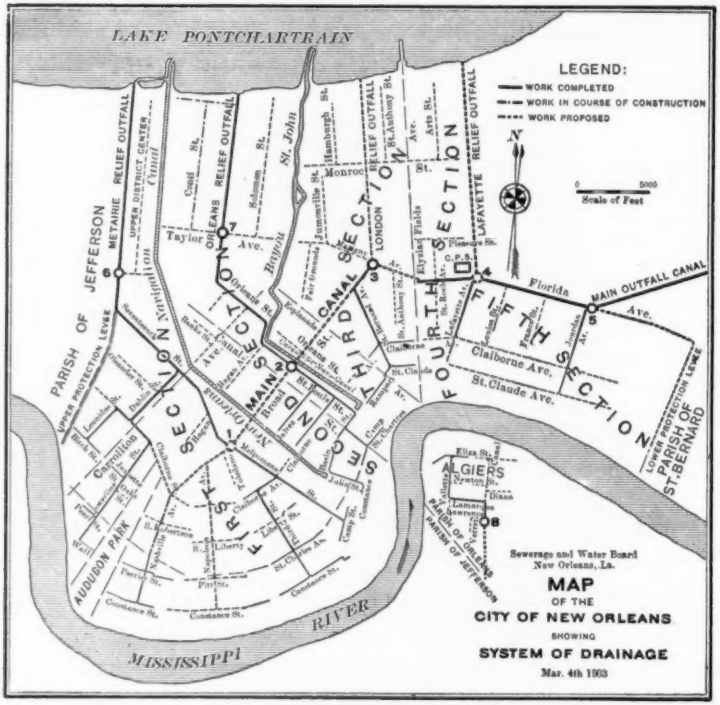
now about half completed. The money available for drainage purposes at the present time has been exhausted and the work will shortly be suspended, and will remain in about its present degree of completeness until additional funds are provided. The area to be drained under this drainage plan consists of about 24,000 acres or 37½ square miles. This area is the subject of rainfalls, the greatest of which for



MAP OF THE LOW LAND.

many years has been about 7½ inches within 24 hours, which is equivalent to a cube of water 870 feet long, wide, and deep. Of course, such a rain occurs only at very rare intervals. In 1894, before work on the new drainage system was commenced, records were kept of the amount of rainfall each year, and these records have been continued until the present time. During the month of July, 1894, 325,739,830 cubic feet of water were drained away from about half

the total area included in the drainage plan. This discharge for one month is equivalent to a cube of water 685 feet on each edge, or to a lake 10 miles long, 600 feet wide, and 10 feet deep, or to a canal 80 miles long, 40 feet wide and 20 feet deep.



MAP OF CANALS, LEVEES, AND PUMPING STATIONS.

The drainage plan adopted provided for a system of canals for the purpose of collecting the water and conveying it to pumping stations by which it is pumped to the level of either Lake Borgne or Lake Pontchartrain, into which it then flows. The plan provides for a continual removal of seepage water and ordinary daily drainage from the soil and the disposal of all such waters into Lake Borgne. It also provides for the rapid removal of storm water, which is to be pumped partly into Lake Borgne and partly into Lake Pontchartrain. Many of these canals are lined and covered with masonry and entirely concealed from view underneath the surface of the streets. Others are open ditches

with sloping earth sides. The engineering features of the canal system proper are extremely interesting, but it is of the pumping stations that the present paper treats.

These pumping stations may be divided into two classes:—those that pump the daily drainage and are intended to operate continuously day and night, and which also are equipped to operate as storm stations in times of flood; and those which operate as storm stations only, it being not the intention to have them handle any polluted water. These storm stations discharge water into Lake Pontchartrain, which is a land-locked lake comparatively shallow, communicating with Lake Borgne and with Mississippi Sound through a comparatively narrow opening known as the Rigolets. This lake as well as Lake Borgne is subject to variations in level, owing to wind storms in the Gulf of Mexico. The range of these variations is 6 or 8 feet.

PILE DRIVER AT WORK, STATION NO. 7.

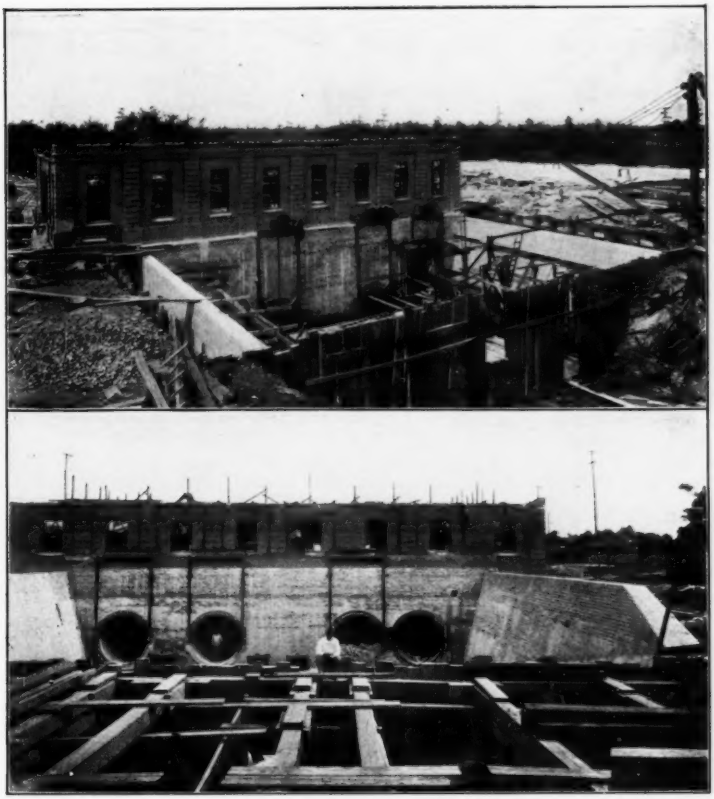
Owing to the very great extent of the work and to the desire of the city to obtain drainage for certain portions before waiting for the completion of the entire system, and before spending the bulk of the money required to build the drainage system, it was decided to build these storm stations first, and to utilize them temporarily for the disposal of all drainage in the city. At the present time the two principal

storm stations have been completed, and are in operation. Three of the other stations with constant-duty equipment as well as storm equipment are complete, but the constant-duty equipment is not operating to discharge water into Lake Borgne as ultimately intended, because the canal system leading to Lake Borgne has not been completed and put into operation. It is not improbable, however, that small canals

THE PILE-DRIVEN FOUNDATIONS FOR PUMPING STATION NO. 7 APPROACHING COMPLETION.

at present existing will be utilized to discharge the daily flow into Lake Borgne before work is wholly suspended upon the system during the current year.

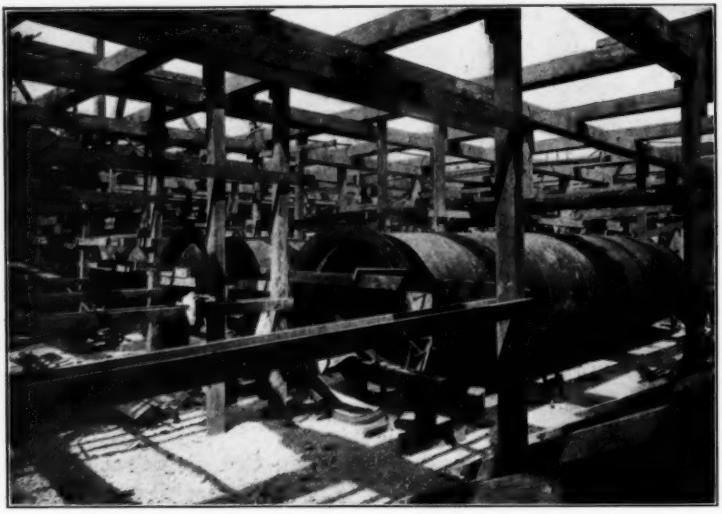
The first to be built and the most important of the storm stations, owing to the fact that it is relied upon to pump the water from the drainage area in the business part of the town, is known as pumping station No. 7. The land in which this station is located is a foot or so below lake level and the station pumps the water from the canals leading to it into a canal leading into Lake Pontchartrain. This outfall canal is provided with levees to prevent the water from overflowing the surrounding country. This pumping station and all others are built upon substantial yellow-pine piling 60 feet or more in length, driven over the entire area occupied by the pumping station and the suction and discharge basins connecting with it. Pumping station No. 7 itself was built directly across an old canal, the water of which was diverted by means of a temporary by-pass. After the piling was all driven (including sheet piling around all of the founda-



STATION NO. 7 DURING CONSTRUCTION. THE UPPER VIEW SHOWS THE SUCTION BASIN; THE LOWER, THE DISCHARGE BASIN.

tion walls) the space between the piles was excavated, the piles cut off at proper elevation, and covered with capping and decking upon which the masonry work was erected. Pumping station No. 7 and pumping station No. 6, which is almost like it, contain submerged centrifugal pumps. It was necessary therefore to make deep excavations, about 25 feet from the surface of the ground. This is difficult in any soil such as exists in New Orleans, especially in the lower parts of the city where the soil is thoroughly saturated with moisture, and where the soil is chiefly Mississippi River sand, a material more like a mixture of silt and ooze than sand, for it is extremely unstable under very slight degrees of pressure. The

DISCHARGE PIPES BEING PLACED AT PUMPING STATION NO. 6. SHOWING THE CONSTRUCTION OF THE FOUNDATIONS.



SUCTION PIPES BEING PLACED AT PUMPING STATION NO. 6.

foundations having been laid, large boiler-iron pipes leading to and from the points at which the large pumps were to be located were installed and the masonry work of the station, including the suction and discharge basins, was completed up to the floor line, and the superstructure of the building properly completed. The pumps themselves and the machinery were installed after the building was under roof.

TRAIN LOAD OF PUMPS FOR PUMPING STATION NO. 7.

All of the pumping stations and the central power house are built of pressed brick and are of similar appearance. The roofs are of slate with tiling at the corners. The cornice work is of galvanized iron, the roof trusses of steel, and the floors of cement. There are three pumps at pumping station No. 7, with a pit for a fourth pump which has not been installed. These three pumps are all alike, and each one has the capacity to throw 250 cubic feet of water per second to a height of 10 feet when operating at normal speed. For lower lifts the quantity of water thrown is much greater, running up as high as 350 cubic feet at small heads. The maximum height to which they are expected to operate is 12 or 13 feet. The pumps are of the centrifugal type, and each pump is driven by a vertical shaft, to the top of which is attached a synchronous three-phase electric motor of 350

kilowatts capacity. These motors have stationary high-potential armatures, which take current direct from the line at 3,150 volts. The moving portion or fields take current at 125 volts, which is supplied by rotary converter in connection with step-down transformers. One set of lines from the central power house is capable of operating motor and rotary. The weight of the shaft and the field of the motor is carried on vertical thrust bearings which consist of several plates

INTERIOR OF PUMPING STATION NO. 6.

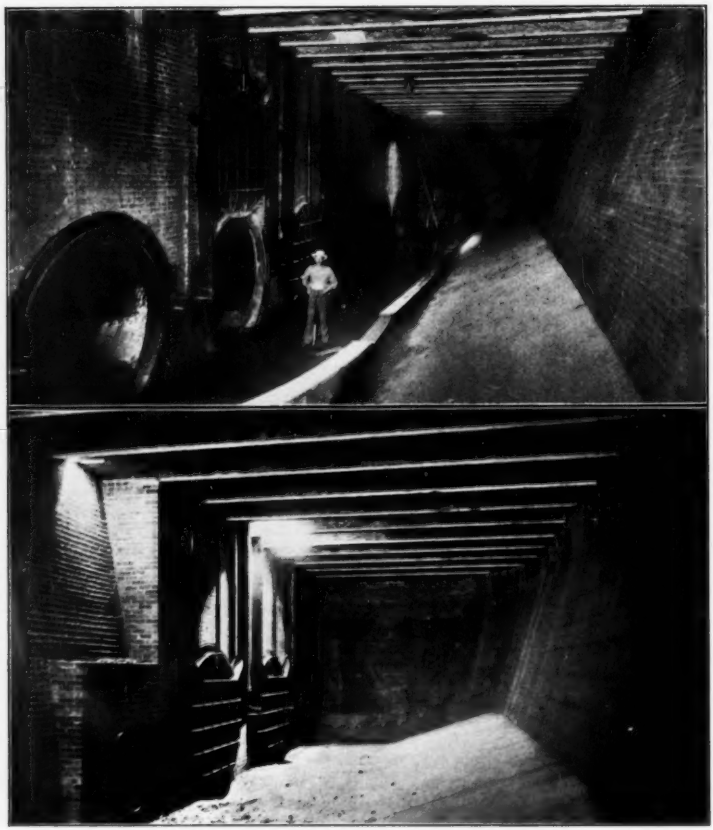
alternately of brass and of iron which turn upon one another. These plates were ground to a fit by the use of sapolio after the pump was installed. These plates run in oil and rest upon a bearing which is water-jacketed to prevent overheating. Some trouble was experienced with these bearings when they were first installed, but after the bearings had been worn to a nice fit they caused no further trouble. As is well-known to all electrical engineers, the difficulties with synchronous motors are the difficulty of starting them and the comparatively small overload which they will carry without danger of their going out of step. There are two methods by which the pumps at station No. 7 can be started, but only one of these methods is actually used. The method which is not used is to pump out the pit

in which the pump is set, so that the pump can be started without any load, then to start the motor as an induction motor, and to throw into synchronism when it comes to speed. The load can then be put on by opening the station gates. This method is very slow on account of the necessity of pumping out the pits before starting the large pumps. The method that is actually employed is to use an engine at the central power house for the purpose of starting up any motor and to start the engine and the motor together, the motor coming up to speed under load at the same time as the engine. This method works admirably and it is perfectly practicable to start up as many pumps as may be desired at one time by this method. The pumps may be stopped by the closing down of the gates and the simple opening of the switch on

EXTERIOR OF PUMPING STATION NO. 6 DURING TEST OF THE CAPACITY OF THE PUMPS.

the electric motor without affecting the running of any other motor. There is no difficulty with the motors going out of step on the pumps at station No 6 and station No. 7, as the load is practically a steady one, and as the motors have a very great overload capacity.

The gates for controlling the water at station No. 7 are of cast iron, strongly ribbed. They slide in special channels and are raised or

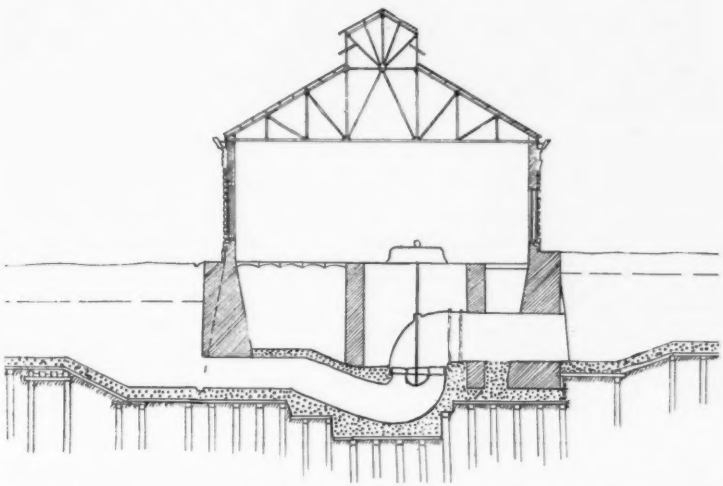


SUCTION AND DISCHARGE BASINS, STATION NO. 3.

The suction basin is shown in the upper view, the discharge basin in the lower one.

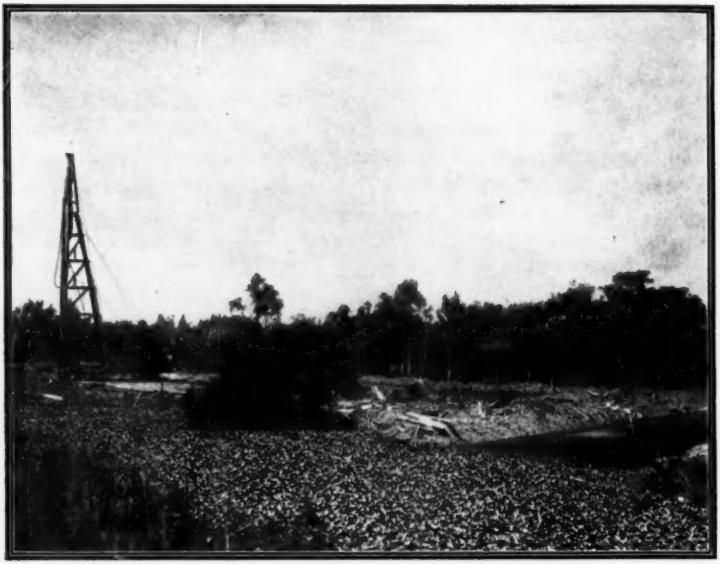
lowered by means of screws which are operated by electric motors. It has been found in practice that a flap gate on the discharge side of the station is very much to be preferred to the type of gate originally installed, and accordingly flap gates are to be installed on the discharge side of the station in addition to the existing gates. This will make it possible to start up and stop any pump without any attention being paid to the opening or closing of gates. The old gates can be left open at all times, except when it is desired to close them for the purpose of making repairs. This station and its sister station, No. 6,

together, with their present equipments, are capable of pumping 1,500 cubic feet of water per second, a height of 10 feet, or 2,000 cubic feet of water per second, a height of 6 feet or less. They therefore provide for the disposal of about 2,000 cubic feet of water into Lake Pontchartrain under the conditions of exceptional storms. Pumping station No. 3 is capable of discharging about 650 cubic feet into the lake under storm conditions, making the total capacity of the drainage system with its present equipment about 2,600 cubic feet per second pumped into the lake under the conditions of exceptional storms, during which the water in all the canals is very high. This will shortly be increased 300 cubic feet by the installation of another pump at station No. 6. 2,600 cubic feet per second is equivalent to a stream of water 10 feet deep and 44 feet wide, flowing at the rate of 4 miles an hour, or the average velocity of the Ohio River, or the rate of an easy walk.



SECTION OF PUMPING STATION NO. 1, SHOWING ARRANGEMENT OF THE WATERWAYS.
The upper (solid) line on both sides indicates the surface of the ground; the lower (broken) line indicates the water level.

Pumping stations Nos. 6 and 7 take their water partly from a territory which is tributary to them without any other pumping and partly from the outfall canals leading to pumping stations Nos. 1 and 2. These two pumping stations are arranged to pump storm water in two directions, first in the direction of the main canal running ap-



SITE OF PUMPING STATION NO. 6, SHOWING BY-PASS, PILE DRIVER, AND OLD CANAL FILLED WITH WATER HYACINTHS.

proximately parallel to the river and eventually discharging into Lake Borgne, and second into relief canals running to stations Nos. 6 and 7, and thence into Lake Pontchartrain. The intention is to pump all of the light storm water to Lake Borgne and to utilize the canals leading to stations Nos. 6 and 7 only for the surplus water in times of heavy storms, which cannot readily be disposed of into Lake Borgne. In pumping stations Nos. 1 and 2 machinery has been installed leading only in the direction of Lake Pontchartrain, and up to the present time no water is pumped along the line of the main canal. At these two stations, however, there have been installed constant-duty pumps as well as storm pumps. These constant-duty pumps discharge in the direction of Lake Pontchartrain, but it is the intention to change the direction of their discharge and pump the water into Lake Borgne as soon as practicable to do so; therefore at the present time the constant-duty pumps are very little used, there being no constant-duty pumps at stations Nos. 6 and 7.

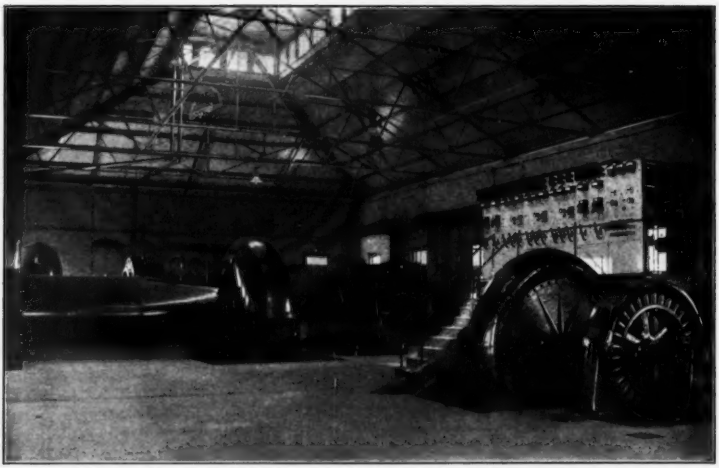
The constant-duty pumps at these two stations are of the submerged centrifugal type operated by synchronous motors similar to the large pumps at station No. 7, but of much less capacity. Each

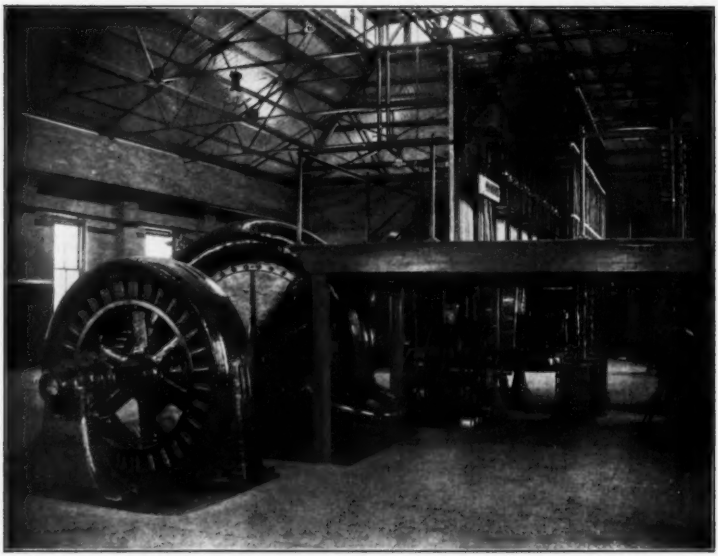
pump has a capacity for lifting water 10 feet or less. The storm pumps at these stations are of the screw type, each capable of pumping 250 cubic feet of water per second a total height of 5 feet; this is sufficient for the purpose of these auxiliary stations, which do not discharge water direct into the lakes, but serve merely to facilitate the flow.

The characteristics of screw pumps are quite different from those of centrifugal pumps. The centrifugal pump takes the greatest load when operating at low heads, while the screw pump takes considerable less load while operating at low head. The screw pumps are more efficient than the centrifugal pumps when operating at exactly the head for which they are designed, but they will not operate as satisfactorily as the centrifugal pumps for excessive heads.

During exceptional storms under present conditions with the water all being pumped into Lake Pontchartrain, the present pumping equipment at stations Nos. 6 and 7 is not sufficiently great to enable the pumps to keep the water down to the proper flood slope in the canals, and in consequence the water rises on the suction side of the station, so as to be pumped only 6 or 8 feet instead of 10 or 12 feet. The result is that these stations throw a considerable excess in quantity of water, and they also take a considerable excess of power over what they would take when operating at normal head. Under these conditions, that is, when the amount of water exceeds the capacity of the pumps, the auxiliary stations Nos. 1 and 2 are of little use, and in fact during such storms there is nothing gained by operating these stations at the present time. During light storms, however, they serve to remove the water rapidly from the densely populated portions of the city. When the entire system is completed, instead of fulfilling a secondary purpose these stations will be of primary importance, and stations Nos. 6 and 7 in all probability will be operated comparatively seldom.

The two pumping stations Nos. 1 and 2 are exactly alike in general appearance, and very similar in arrangement. The general features of the machinery are identical, but it was found by experience at station No. 2, which was built first, that great improvement could be made in the arrangement of the watercourses, and in consequence the arrangement of the pits leading water to the pumps at station No. 1 was very materially changed from the present arrangement at station No. 2, and it is highly desirable that the pits at station No. 2 shall be changed to correspond with the arrangement of the pits at station No. 1.





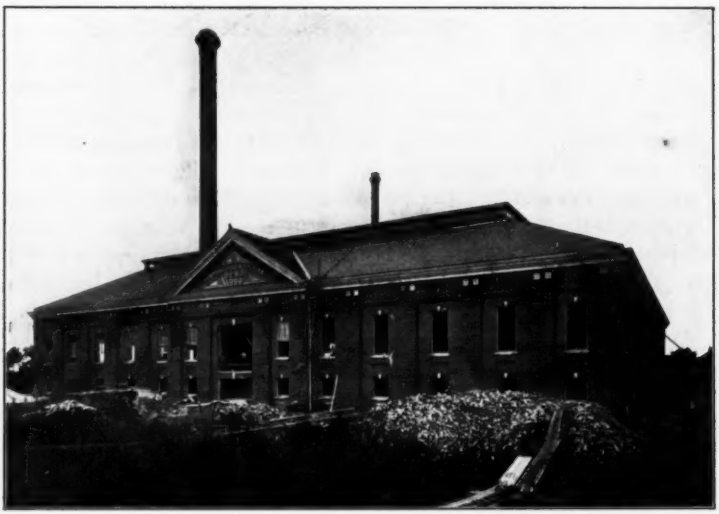
INTERIOR OF PUMPING STATION NO. 3. THE UPPER ENGRAVING SHOWS THE GENERAL VIEW. THE LOWER SHOWS THE ELECTRICAL CONNECTIONS BEHIND THE SWITCHBOARD, ALSO THE ROTARY AND TRANSFORMERS; CONSTANT-DUTY PUMP ON THE LEFT.

The gates at station No. 2 are similar in principle to those at stations Nos. 6 and 7, but at station No. 1 flap gates have been installed These gates are kept from closing suddenly by large dash-pots or controllers similar in principle to the small dash-pots often placed on doors. The dash-pots are filled with water and the rapidity of the closing of the gates depends upon the size of an opening connecting one side of the piston with the other. These two sides of the piston are joined together by a pipe in which is placed a controlling valve to regulate the rapidity of the motion.

Pumping stations Nos. 1 and 2 are operated in the same manner as stations Nos. 6 and 7. The process is exceedingly simple, and is as follows: Whenever it is desired to start any pump or any set of pumps, the station attendant calls up the central power house over the telephone, and notifies the power house to furnish current. He then closes the switches on his switchboard connecting the rotary converter and the pumps which he wishes to start with the proper line. The engineer at central station starts up his engine and brings it up to a certain speed. He then slacks the speed a trifle and while he is slacking the speed the attendant at the pumping station closes a switch which turns into the fields of the synchronous motors, thus putting them in step with the generator at central station. The engineer at central station is informed of the fact the moment the motors are in step by looking on his electrical instrument, and he then increases the speed of his engine to the normal speed. He is then able to continue to run these motors on that engine or to transfer the load to any other engine or any combination of engines without any difficulty or complication, and without shutting down. By this method it is possible to start up any number of pumps at the same time with very great economy and without any undue strain on any part of the equipment, either electrical or mechanical.

The four pumping stations which have been described are all equipped with submerged pumps. Another pumping station, station No. 3, has recently been completed, in which all of the pumps stand above the floor line. Pumping station No. 3 is arranged to discharge water either direct into an outfall leading to Lake Pontchartrain, or along the main canal leading to Lake Borgne. The present equipment discharges into Lake Pontchartrain only, and contains two pumps of 250 cubic feet per second capacity each, with a lift of 8 feet, and one constant-duty pump with a lift of 16 feet. These pumps are all of the same general design. They are operated by synchronous electric motors on horizontal shafts direct-connected to the runners

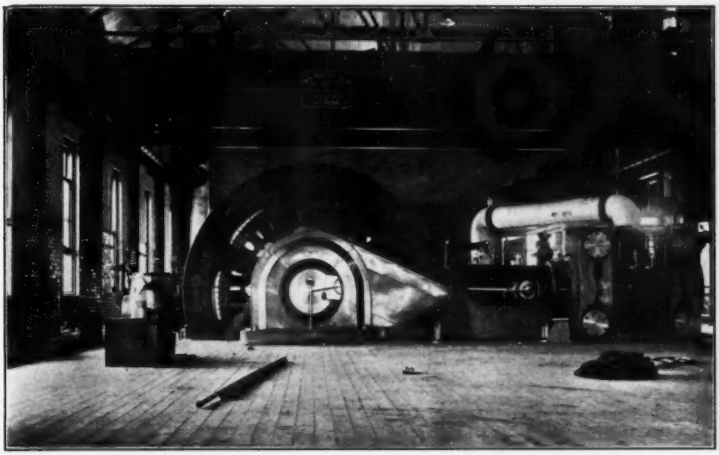
of the pumps. To start these pumps the motors are brought up to speed while the pumps contain no water. This is done by starting the generator and the pump at the same time. It is necessary to prime the pumps by pumping the air out of the pumps and the penstocks, so that the water will rise and fill the pumps. The pumps are put out of service merely by allowing air to enter them, or by slowing down and allowing air to enter. For a station arranged as this is no gates are necessary, as the pumping apparatus is above water level, and all that is necessary to prevent water from flowing through the station is to break the vacuum. There is an objection to having the constant-duty pump above the floor line, however, which is that this pump is intended



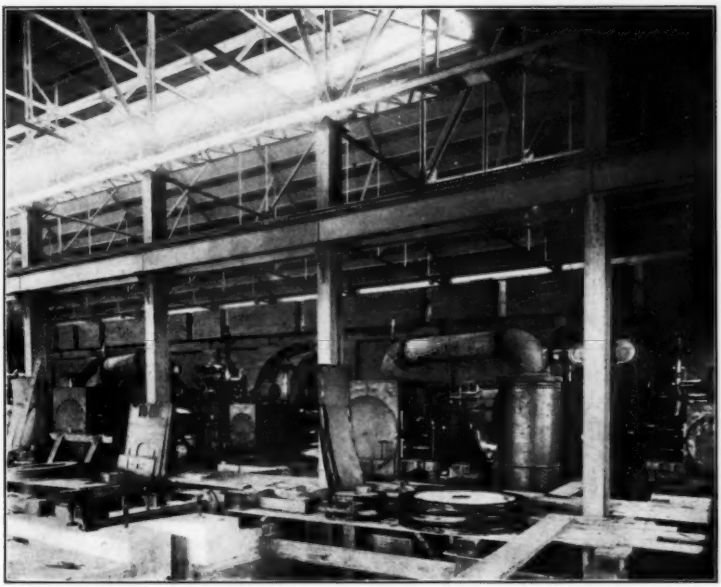
FRONT VIEW OF CENTRAL POWER HOUSE, IN COURSE OF ERECTION.

to keep the canals pumped almost dry during ordinary weather, and that as a pump above the floor line thus implies a very considerable syphonic action in the suction and discharge pipes, it is difficult to maintain the necessary vacuum with water at comparatively high temperature such as exists in the drainage canals in the summer time.

The general design of the drainage system provided for the water being pumped successively at the various stations Nos. 1, 2, 3, 4, and 5, at the last named of which it passes into an outfall canal leading to Lake Borgne. At each pumping station the volume of water is increased by that which flows in from the section in which the pumping



THE LARGEST ENGINE AND GENERATOR IN THE POWER STATION.



MACHINERY ROOM, CENTRAL POWER HOUSE, BEFORE THE PLACING OF THE FLOOR.

INTERIOR OF ST. LOUIS CANAL. (COVER NOT QUITE COMPLETE.)

station is located, so that each successive station has a larger equipment than the one preceding it. At the present time stations Nos. 4 and 5 have not been built owing to lack of funds, and the main canal connecting these various stations has not been built, except near where station No. 5 will ultimately be constructed. There is, however, an old but small canal along the line of this main canal which is not now used except as a branch canal to collect local drainage. The relative merits of the different pumping stations that have been built will afford valuable information concerning the construction of the two pumping stations to be built in the future, and as the work of building these stations will probably be postponed for a number of years, there will be ample opportunity for working out the problem so as to utilize every available advantage.

To operate these various pumping stations, a central electric power house has been constructed with ample floor space for installing all of the machinery that will be necessary to complete all of the future installation, but with the present installation of machinery sufficient only to operate the pumps that have already been installed. The station is divided into two parts, the boiler room and the machinery room, the boiler room being in the rear and the machinery room in front. The boiler room is arranged to have all of the boilers in one

row. Suitable arrangements for bringing in coal have been provided, and all of the existing boilers are provided with mechanical stokers. The engine room is divided into two portions, in one of which was placed the first machinery installed, while the second affords room for future machinery. At present there are installed a number of engines and generators varying in capacity from 100 horse power to 1,500 horse power. Each of these units can be operated separately and connected to any individual pump in the drainage system, or any number of these units can be operated in multiple and connected in multiple to any number of pumping units. The generators are three-phase synchronous machines. The vacuum of the steam exhaust is not as low as is frequently obtained in northern cities, owing to the temperature of the water used for cooling. This water is taken from an open canal which circulates around the power house, and which is exposed to the action of the rays of the sun during the entire day. No better source of water is at present available for this purpose.

From the central station two sets of feeder lines run to each station, upon either one of which the station can be operated, but both feeder lines are used under ordinary conditions. The pole line which carries these feeders also carries a private telephone circuit. The various stations also have communication with the telephone exchange of the city, and central station has a private line to the office of the general manager of the operating department in the city hall.

This is one of the most important, unique, and instructive electrical plants in the United States. The purpose for which the current is used and the peculiar conditions necessary to perform the drainage of this city properly are unparallelled among the applications of electric-power transmission. The drainage problem itself is of very great difficulty and of great interest, and a certain amount of experimentation has been unavoidable in the past, while future additions to the system, in order to be made properly, must be based upon a careful scientific study of the behavior of what has already been built.

GREAT ELECTRIC INSTALLATIONS OF ITALY.

By Enrico Bignami.

THE HYDRO-ELECTRIC STATION OF CENISCHIA.

The power station described by Signor Bignami is interesting as an example of the use of very high-head water power in connection with long-distance electric transmission—practice which is finding its most striking expression on the Pacific Coast of North America, while huge possibilities are open in the Scottish Highlands. It is interesting further in that it shows the export opportunities in engineering. This Italian station represents the skill and the industrial energy of American, English, German, and Swiss engineers and manufacturers.—THE EDITORS.

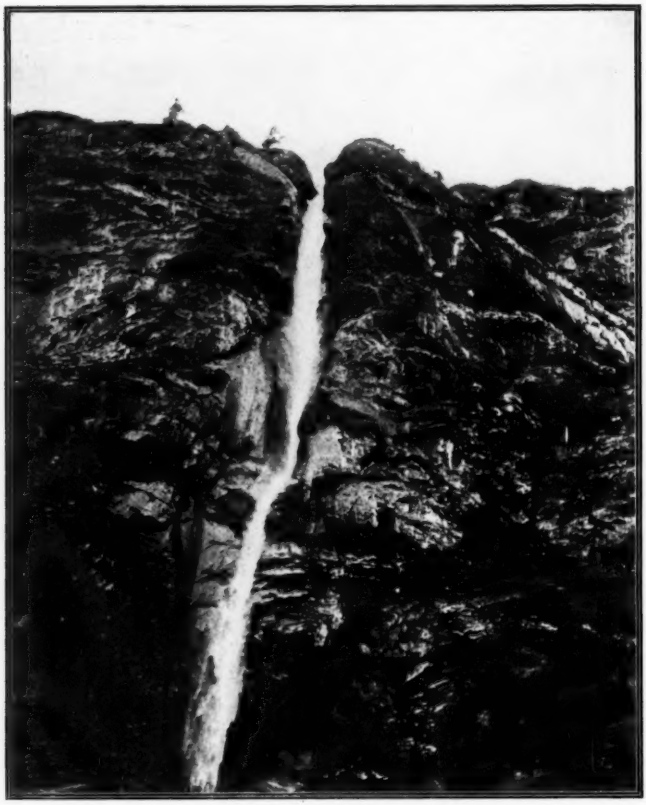
AMONG the many Italian water powers, the installation of Cenischia, now under construction by the "Societa delle Forze Idrauliche del Moncenisio" (an incorporated company with a capitalisation of 4,000,000 lire) in the plain of the Novalesa near Susa, is of particular interest on account of its wide differences from preceding undertakings.

The Cenischia torrent, a tributary on the left of the Dora Riparia, rises on the slopes of the chain of Alps extending from the Bard glacier to the Lamet glacier—a chain which spreads like a vast ampitheatre, crowning with its peaks the wide plateau of Cenisio (Mont Cenis) in which lies the lake of the same name. The area of the basin is about 80 square kilometres; that of the lake of Cenis (which acts to some extent as a regulating reservoir for the outflow) is 2,000 hectares. The altitude is 1,910 metres, or about 6,250 feet above sea. The outlet of the lake is the Cenischia, a stream of very variable volume. Impetuous as a torrent in the season of melting of the snows, it maintains almost a constant flow during the summer, falling to a minimum in the month of February. This minimum flow is calculated at 800 litres a second, corresponding closely to 10 litres per square kilometre of watershed. About one kilometre below its exit from the lake the stream reaches the exit from the high valley of its source; near Gran Croce it receives as tributary the outlet of two other small lakes—Lac Blanche and Lac Noir—and thence follows a course parallel to the great road which Napoleon built over Mont Cenis. At about ordinate 1,720 it turns sharply to the east, skirting the village of Ferrara, and leaping from rock to rock, it reaches

THE BARD CASCADE, NOVALESA.

the bottom of the lower valley near to Novalesa, having fallen nearly 900 metres in a course of about 5 kilometres. Beyond Novalesa the valley falls gently, and the Cenischia flows through it smoothly in an ample bed toward its confluence with the Dora Riparia.

The highly favourable conditions thus presented suggested to Italian engineers and to foreign financiers the possibility of developing the water power of the Cenischia, in an installation of large capacity and under most promising economic conditions. The first studies of the "Societá delle Forze Idrauliche del Moncenisio" were directed toward the utilisation of the whole of the available power by two stations, dividing the fall into two parts—the first of 415.19

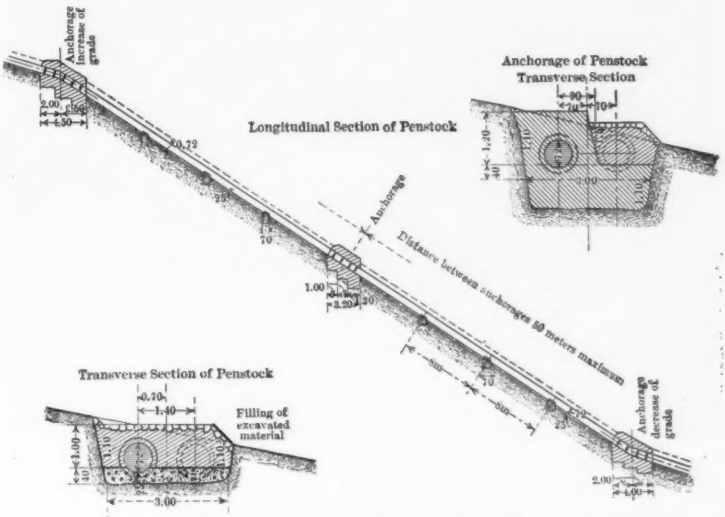


THE CLARETTA FALL, NEAR NOVALESA.

metres, from ordinate 1,707.49 to ordinate 1,292.30, and the second of 433.70 metres, from ordinate 1,292.30 to ordinate 848.60. There is now under discussion a variant of these plans, by which a single fall of 859 metres would be utilised. The project is completed by the regulation of the regimen of the lake so as to make of it a storage reservoir for providing a constant flow of 1,020 litres, which may possibly be raised to 1,400 litres, giving a potential nominal horse power of 16,000. All the work is constructed with a view to the ultimate usage of the 1,400 litres.

Near to the repair station No. 5 on the Mont Cenis road, at a point where a quiet stretch of the Cenischia serves as a sort of settling basin, are the first headworks. They consist of a strong masonry dam, 15

metres long, across the channel of the stream. The intake is on the right bank, where a small reservoir with discharge opening is provided. From the gate house on this reservoir leads a masonry canal, entering at once into tunnel; at about 100 metres distance from the intake is the weir for regulating the volume of flow in the canal. It follows thence the line of the National road, the tunnel of the old Fell Railway, and comes out on the open slope of the mountain. Following along the hillside sometimes in the open and sometimes in tunnel, it reaches the ridge of the spur limiting the watershed of the Bard, where the penstock begins. The length of the flume is 2,500 metres, its breadth 1.00 metre, and its depth 1.35 metres. It is of masonry, laid in cement and carefully pointed, and its open stretches are covered over with stone flags to protect it from ice and landslides—the constant enemies of masonry construction at these altitudes. The work throughout, therefore, is on but a small scale, but every inch of the space it occupies has been wrested, bit by bit, from the mountain side; it exhibits, moreover, the distinctively Alpine character belonging to the region.



SECTION OF PENSTOCK AND ITS ANCHORAGES.

At ordinate 1,707.49 is situated the charging and settling basin and the last weir. As it is the plan of the company to operate at least a part of the plant at the earliest possible date, the lower fall alone will

be utilised at first, the upper one being not in penstock but left as an open flume, of the same form as the race above, bringing the water to the intermediate station. This flume is excavated wholly in the rock, and consists of a series of descents and basins, spaced 50 metres apart, with steps and cross-sills intercalated to check the speed of the water and prevent damage by erosion. As already stated, it is 1 by 1.35 metres in section, covered over with flat stones, and with cement-masonry walls most carefully pointed to avoid any loss by leakage. Each litre of flow represents a potential energy of 12 horse power (nominal) at the turbines. The length of this flume is 1,750 metres and the descent is 415.19 metres.

OPEN CANAL, THE PRESENT SUBSTITUTE FOR THE UPPER PENSTOCK.

From the intermediate station, the place of which is taken for the present by a charging basin, descends the penstock of the lower fall, from ordinate 1,292.30 to ordinate 848.60. It is composed of two parallel wrought-iron tubes laid in a cutting and anchored solidly to the ground every 50 metres and at each change of grade, which sometimes exceeds 70 per cent. The pipes composing the tubes are each

5 metres long, 0.72 metres internal diameter, and the metal of the walls has a maximum thickness of 21 millimetres. Every fifth joint—that is, every 25 metres—they are put together with a flanged joint having a rubber gasket 3 centimetres thick. In the lower portion of the penstock, for about one-third of its total length, the pipes are weld-jointed; elsewhere they are made of rings of iron plate lapped and

THE PENSTOCK, AND PART OF THE POWER STATION.

fastened with a double row of rivets. To make them as tight as possible against the very high pressure of the water, all the joints are caulked. The weight of a single tube for the lower fall is about 270,000 kilogrammes and its length 1,060 metres; the working stress of the iron is 10 kilogrammes per square millimetre (14,220 pounds per square inch) allowing 15 per cent. increase over the static pressure for hammer blow. The velocity of the water is 1.72 metres and the volume 0.70 cubic metre per second.

The Novalesa station (next page) contains now three groups of turbo-alternators and later will contain five groups. The upper station will be the same; the entire installation will thus include ten turbo-alternator units. In addition there are now installed at Novalesa two turbine-driven exciting dynamos and four transformers; these

THE NOVALESA POWER STATION.

latter will be eight in number in each of the power stations when completed.

The turbines were furnished by Piccard, Pictet & Co., of Geneva. Each of those intended for driving the alternators is of 1,600 horse power at 500 revolutions with an effective head of 436 metres, and requires 360 litres per second. The wheel is banded with a ring of rolled steel shrunk on. The water is delivered to the turbine through a horizontal cast-steel pipe extending inside the wheel, where it is bifurcated and terminates in two distributors with nozzles of variable section, suggesting in their construction the slide valve of a steam engine. The inner surfaces of the nozzles have graduated curves, so arranged that the direction of the issuing stream remains the same whatever be the position of the opening.

Regulation is effected by a trip-geared auxiliary motor, very simple in construction, so arranged that all parts are readily visible and accessible, and therefore secured against the troubles common to hydraulic regulators when the water is turbid. Hand regulation is also provided. Other features of the construction secure great uniformity of speed, which is of the utmost importance to the parallel working of the several groups. The gates are furnished with by-pass connections.

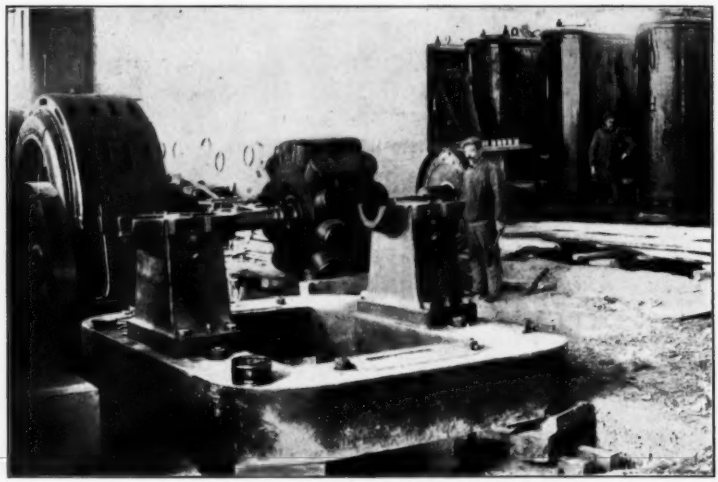
The turbines for the exciter dynamos are of 110 horse power each at 600 revolutions; they have single distributors.

The alternators were furnished by the Thomson-Houston Co. and built by the Union Elektricitäts Gesellschaft, of Berlin. They are three-phase, 1,400-kilowatt machines, each capable of taking the entire power output of one of the 1,600-horse-power turbines, and working with a power factor of cos $\Phi = 0.8$. They have 12 poles and generate current at 3,000 volts, with a frequency of 50 periods per second. They are direct-connected to the turbines by Passard joints. The alternators require 12.3 kilowatts at 125 volts for their excitation, when cos $\Phi = 0.8$. The total weight of each is about 35,000 kilogrammes, the moment of inertia of the revolving part 12,600 kilogrammes, the peripheral speed of the revolving part 42 metres per second, and the efficiency at full load, with cos $\Phi = 0.8$, 95 per cent.

The exciters are by the same makers, compounded, four-pole, each of 75 kilowatts at 125 volts.

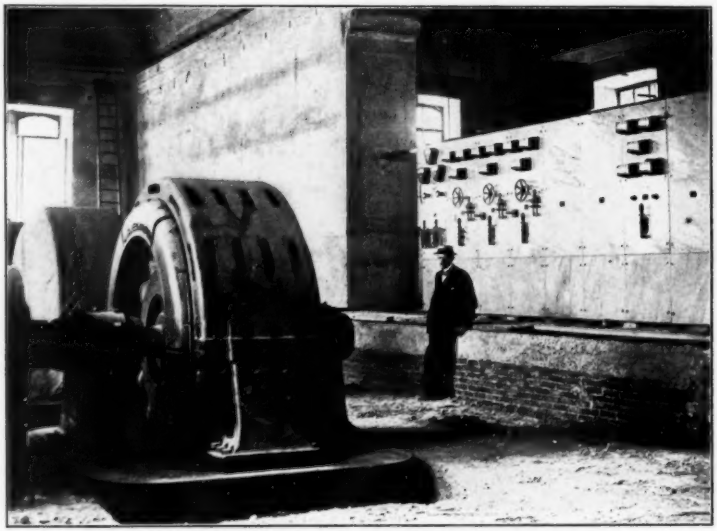
The transformers, furnished by the Thomson-Houston Co., are the product of the General Electric Co., of New York. They are single-phase, three of them being star-connected and the fourth held in reserve; by a proper arrangement of switches the fourth may be substituted for any one of the other three. Each transformer is of 1,100

PARTLY ERECTED ALTERNATORS IN THE NOVALESA STATION.



INTERIOR OF THE POWER STATION AND TRANSFORMER ROOM DURING CONSTRUCTION.

kilowatts capacity, placed in oil and cooled with water circulation provided by two small motor pumps run by the exciting machines. The transformers raise the pressure from 3,000 to 30,000 volts, and at



DYNAMO ROOM WITH SWITCHBOARD IN COURSE OF ERECTION.

full load have an efficiency of 98.3 per cent. with cos $\Phi = 1$, and of 97.3 per cent. with cos $\Phi = 0.75$.

There is a special distributing switchboard, all the apparatus subject to high-potential current—such as the oil switches and circuit breakers, the bus bars, fuses, etc.—being removed entirely from the operating switchboard and mounted entirely separate. All the cables

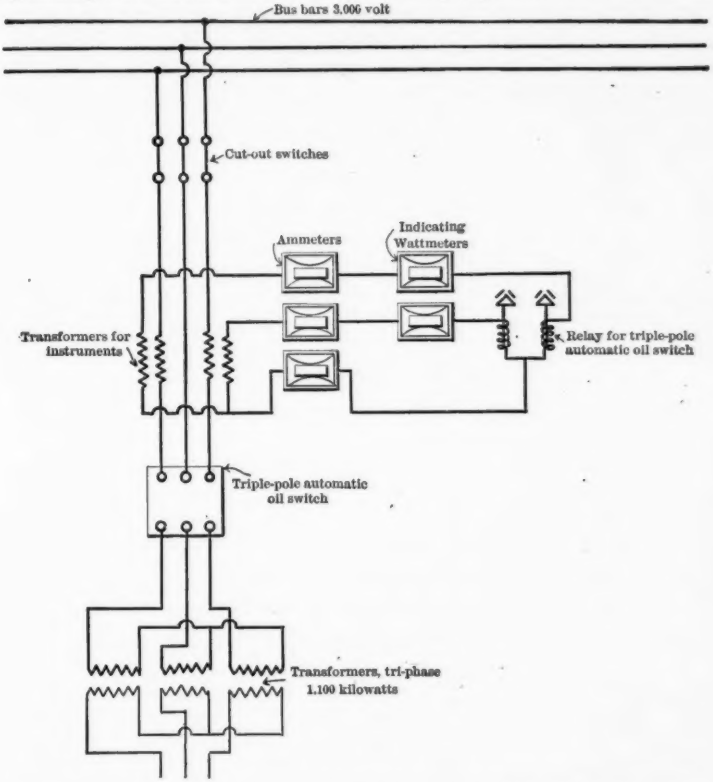
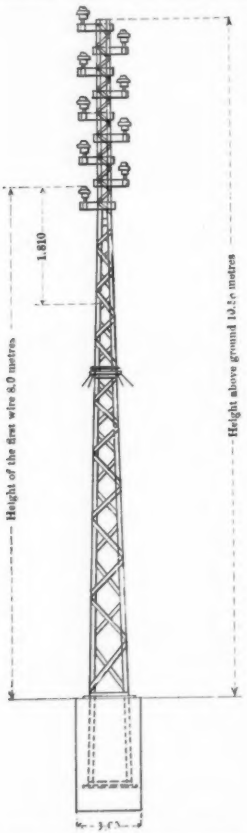


DIAGRAM OF CONNECTIONS OF THE MEASURING INSTRUMENTS AND TRANSFORMERS.

are heavily rubber-insulated and mounted on porcelain insulators. The operating switchboard contains one panel for the two exciters, five panels for the five generators, and two panels for the feeders of the two transformer groups. On the generator panel the apparatus is simply the ampere meter for alternating current, the ampere meter for the exciter current, and the volt meter which serves also for synchroni-

sation. On each of the transformer-cable panels there are three ampere meters, to measure each phase, and two indicating watt meters whose readings are to be added.

A corridor below the dynamo room contains the cables from the alternators to the distributing switchboard, the circuit breaker for 300 amperes at 3,000 volts, and the transformers for the three-phase current. The circuit breakers are placed just where the cables come out of the foundations of the generators, and are separated by partitions and also so placed that no damage to the cables could result from the flame due to the fusion of one of them. In a room below that containing the operating switchboard are placed the three-pole oil switches for the 3,000-volt circuits; they are operated by handles and levers from the board above. These oil-break switches are set in small alcoves in the masonry, which are covered over with marble slabs; across these pass the cables to the 3,000-volt bus bars. There are five of these circuit breakers for the five three-phase generators (300 amperes at 3,000 volts) and two of 750 amperes at 3,000 volts for the two 1,100-kilowatt transformer groups raising the potential to 30,000 volts. These latter are automatic. In all, the current is broken at two points in series for each phase, and the break is effected under oil, contained in a vessel enclosing the whole apparatus.



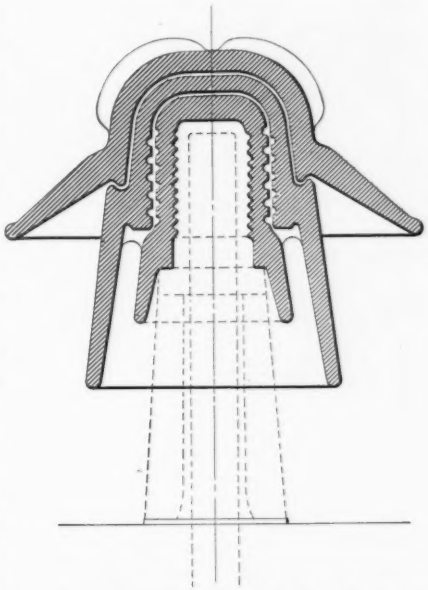
POLE OF THE TRANSMISSION LINE.

An interesting novelty in this switchboard is the arrangement by which the three ampere meters for the three phases of a circuit are supplied with current by two transformers, which also supply the automatic cut-outs and the indicating watt meters.

Wirt lightning arresters are used, made in 200-volt sections, each consisting of five small brass cylinders and two carbon rods The number of sections placed in series used for the protection of any one circuit depends on the voltage of that line.

At the Novalesa station the lightning-arrester sections are placed in two rows on wooden framework carried on opposite sides of a wall, and are separted from one another by partitions.

The transmission line from Novalesa to Turin—about 61 kilometres—is now under construction. It is carried on iron poles furnished by the "Societá Nazionale delle Officine di Savigliano"; these poles have a minimum height of 10.5 metres above ground, and are normally spaced 75 metres apart. For the present the line has six wires of 6.75 millimetres diameter each, being designed for the transmission of 4,200 kilowatts. When the installation is complete three more wires of 9.1 millimetres diameter will be added, providing thus for the transmission of 8,200 kilowatts. The insulators are of a type specially worked out by the company, triple-petticoated, and are carried on wooden arms. The tension of the current delivered is about 27,000 volts. The line is divided into three sections of approximately equal length.



TRIPLE-PETTICOATED INSULATOR OF THE TRANSMISSION LINE.

The transformer sub-station at Turin (Borgata Campidoglio) is under construction, the transformers being supplied by the Oerlikon works. They are of 1,000 kilowatts each, three-phase, oil and air-cooled, and step-down the primary tension of 27,000 volts to the secondary of 3,000. Their weight is 11,000 kilogrammes each; the loss of tension for cos $\Phi = 0.75$ is 3¼ per cent.

The work is being energetically pushed, and in very short time the company will be in position to begin the distribution of electric power. It is estimated that the cost per horse power of the completed installation will not exceed 500 francs, and this will allow the company to realise good profits from the sale of power at very moderate prices.

THE DEVELOPMENT AND USE OF THE SMALL ELECTRIC MOTOR.

By Fred M. Kimball.

III.—THE CHOICE OF MOTORS FOR MACHINE SHOP AND FACTORY.

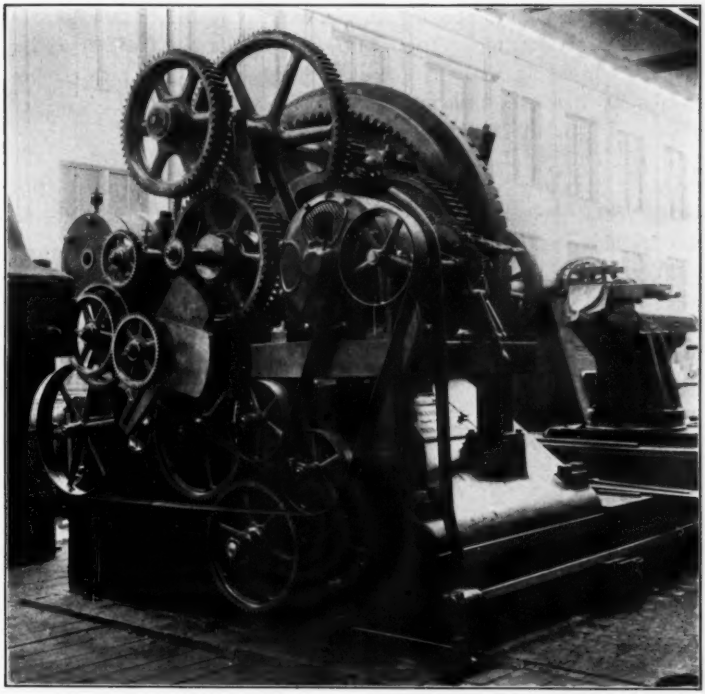
Mr. Kimball's articles, which began in the April number of the Magazine, have already discussed the history and the economy of the electric motor, and its particular adaptation to the machine shop. The preceding article, in May, was especially important by reason of the points it gave concerning the driving of machine tools, and the power required for standard tools and operations. The following number—June—will take up applications of electric driving to a wide range of manufacturing operations.—THE EDITORS.

BEFORE discussing the choice of motors for any given work, let us briefly consider the great general classes into which motors may be divided, and the several types of each class.

In the first class—motors operated from direct-current circuits—we have three principal types; in the order of their development they are: series-wound motors, shunt-wound motors, and compound-wound motors.

The series-wound motor has its armature and fields connected in tandem and the same strength of current passes through all the windings; hence, the conductors in the field spools must be relatively large in cross section and capable of passing as much current as the armature. This motor has no speed regulation worthy of the name, and it is adapted for use only where heavy starting torque is required and where its operation is constantly under the manual control of the operator, or where it is driving a definite and fixed load. It is a very valuable motor within its proper sphere. Practically all railway and automobile motors are series wound, as well as those for crane service.

The shunt-wound motor has its armature connected across the line supply. The field winding is connected in parallel or derived circuit with the armature. In this motor the armature current may be varied without sensibly affecting the field current, and in general the armature current in amperes is very much larger than the field current; hence, the field winding is of relatively small wire. A properly designed shunt motor possesses good inherent speed regulation and a fair starting torque. It is particularly adapted for machines where the load comes on gradually, which are subject to variations without violent fluctuations in power requirements, and where close speed regulation is needed.



122-INCH SELLERS LATHE, SHOPS OF THE WESTINGHOUSE ELECTRIC & MFG. CO., DRIVEN BY 10-HORSE-POWER WESTINGHOUSE ALTERNATING-CURRENT MOTOR.

The compound-wound motor combines in large degree the features of the series motor and the shunt motor. In addition to the fine or shunt winding, another coarse or series winding on the field is added. As usually arranged, the same volume of current circulates in the series field coils, which have comparatively few turns, as circulates in the armature. Generally speaking, these motors do not possess as satisfactory speed regulation as shunt-wound motors, but they possess superior starting torque, and are to be chosen when the power demand is very widely fluctuating and irregular. The greater the degree of compounding the less satisfactory will be the speed regulation. Usually a compounding of from 20 to 25 per cent. will give the best all-around results.

The second class comprises alternating-current motors. These may be single-phase or polyphase. Single-phase motors usually pos-

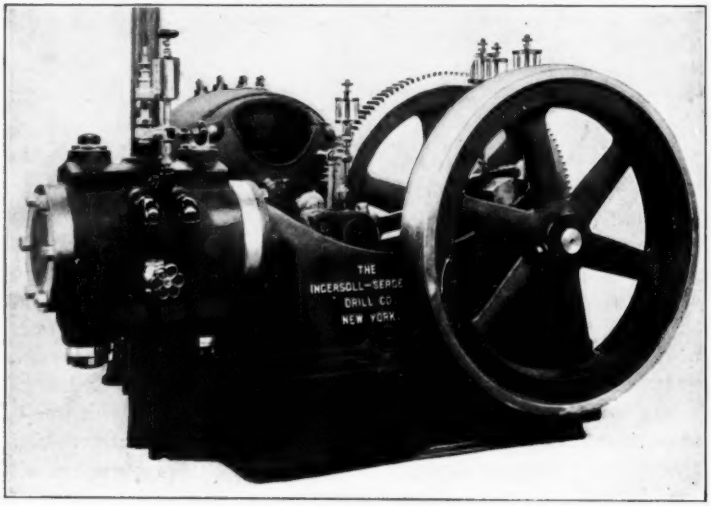
sess comparatively low starting torque, while polyphase motors possess relatively high starting torque. The speed regulation in either variety of motor is good. Usually large sizes of polyphase motors only are provided with synchronous winding. Such motors keep practically perfect speed with the generators which supply them.

Synchronous motors are not ordinarily self-starting, however, and are very little used in machine shops or in connection with machine tools. They are rarely built in sizes as small as the motors we are here considering.

Alternating motors used with machine tools or in factories are generally of the induction type. The speed of induction motors may vary from nearly full synchronism with their supplying generators under no load to a slip of 5 to 7 per cent. or more on full load.

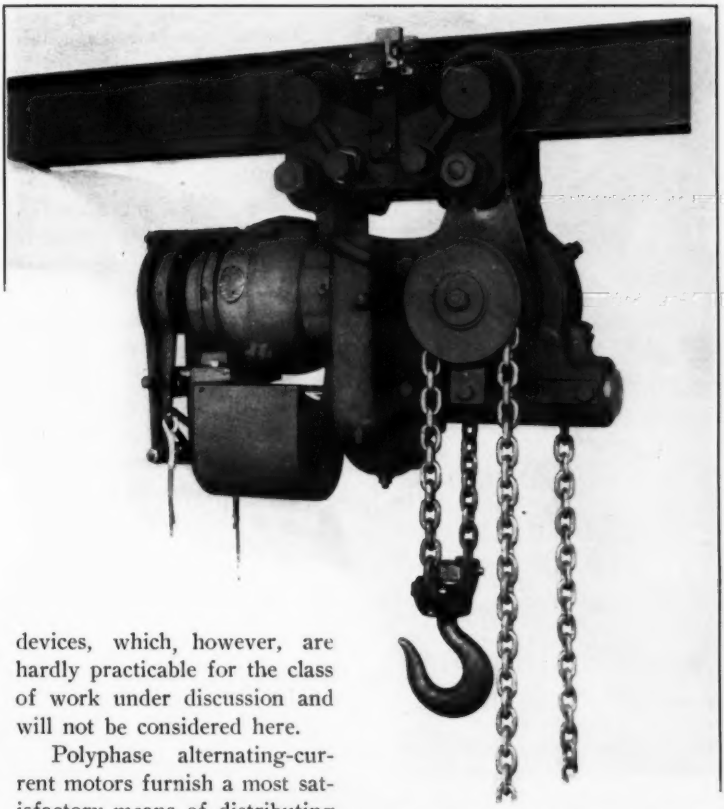
The speed of a direct-current motor may be varied within certain limits by strengthening or weakening the field without sensible loss of output. It may also be varied by supplying a greater or less volume of current to the armature.

The speed of alternating-current motors may be controlled within limits by the introduction of resistance into the armature circuits, by changes in pole grouping, or by means of special compensators or other



MOTOR-DRIVEN AIR COMPRESSOR.

Ingersoll-Sergeant Drill Co.; General Electric motor.

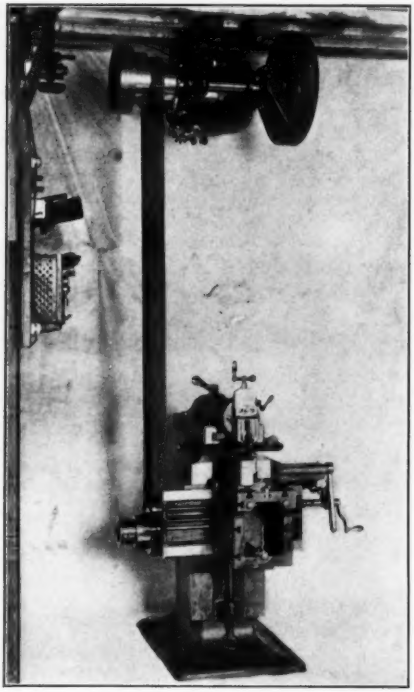


ELECTRIC-DRIVEN CHAIN HOIST, WITH PLAIN SINGLE-TRACK TROLLEY CARRIAGE.

Capacity 2,500 pounds. Sprague Electric Motor.

devices, which, however, are hardly practicable for the class of work under discussion and will not be considered here.

Polyphase alternating-current motors furnish a most satisfactory means of distributing electric power in factories and shops, where the major portion of the machines do not necessitate a wide range of speed control. They are especially valuable in an establishment where it has been decided to use a number of short distributing shafts, each shaft being driven by a single motor. In cases where the larger portion of the machinery, in any given plant, may be operated by alternating-current motors, but some variable-speed work is necessary, a motor-generator set, operated from the alternating-current mains, may be used to furnish the direct current needed for cranes and variable-speed machine tools. Direct-current motors are usually selected for equipping individual tools when wide ranges in



16-INCH GARVIN SHAPER DRIVEN BY GENERAL ELECTRIC MOTOR.

Motor is 2 horse power, 500 volt, 1,200 revolutions. Back geared at ratio of 5 to 1.

speed and close control are essential. It is not usually practicable, when using a standard direct-current motor of given normal output, to vary its speed, with a maintenance of this output, more than 5 per cent. to 10 per cent. either way by field control. With special ratings and windings the range of speed obtainable by field control may be extended within wide limits. It is practicable to decrease the speed of a direct-current motor as much as 50 per cent., or even more, with attendant loss of power, by the insertion of armature resistance. This is not an ideal method, nevertheless, when used constantly or to produce large changes.

It is impossible to produce wide ranges of speed in a motor of any normal given size and maintain constant horse-power output. To realize both conditions, the motor must be a relatively large and heavy one.

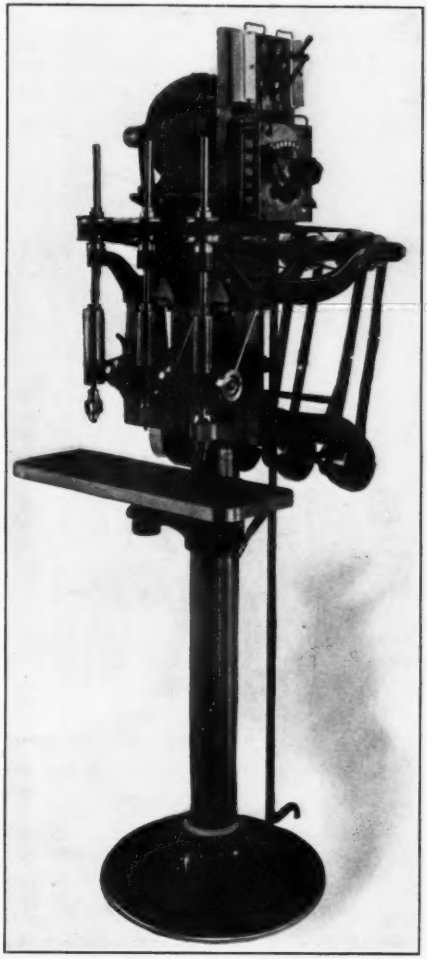
The question of electricity supply must also be borne carefully in mind when any particular problem is under consideration. It is quite possible by means of the so-called multivoltage system and the use of suitable motors in connection therewith, to extend the range of speed control between very wide limits. The use of the multivoltage system demands, however, either special and rather expensive generating plant or the use of compensators, motor generators or their equivalents. It also means a more complex system of wiring and greater expense in the installation of the same. In cases where a large establishment is to be equipped and where many variable-speed motors

are required, it is always judicious to give this system full consideration; but in an ordinary factory, which is taking its power supply from a central station, or in a factory where requirements of variable speed driving are of secondary importance, this method will generally be found rather too expensive for the results obtained.

One should never lose sight of the fact, however, that where multivoltage systems are used and a wide range of speed control thereby obtained, comparatively large, heavy, and therefore expensive, motors must be employed.

In the greater number of cases which we meet, two- and three-wire systems of supply only are most conveniently available whether from central station or isolated plant. As has been pointed out above, motors may readily have a range of field control of one to two on the two-wire system, and on a three-wire system of one to four.

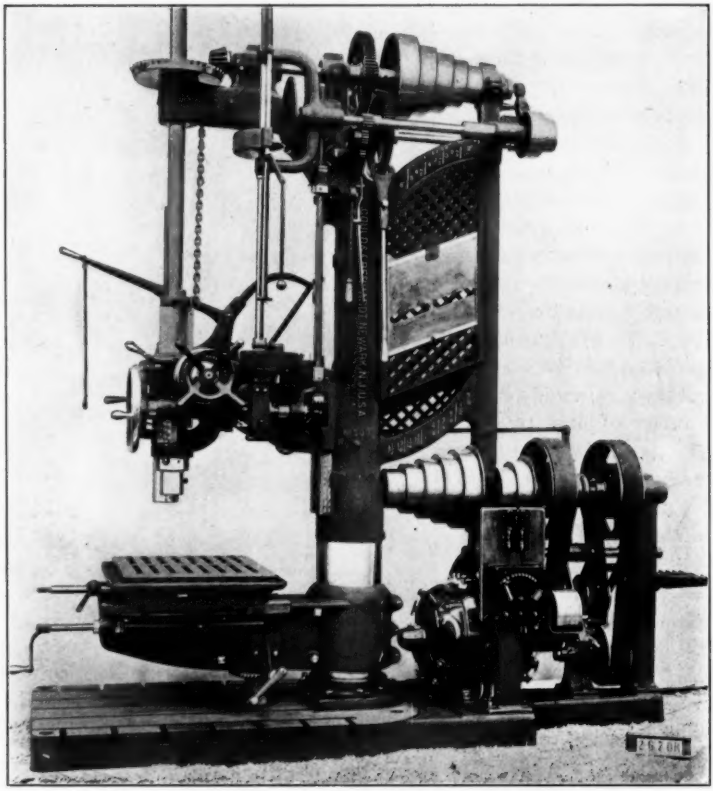
It is comparatively easy and inexpensive in the case of 230- or 500-volt direct-current supply to split the voltage by using a small motor generator and thus provide a third voltage midway between the others. Or, it is equally possible in the case of 115 or 230



BULLOCK MOTOR DRIVING SIGOURNEY THREE-SPINDLE SENSITIVE DRILL.

volt supplies, by similar means, to make double voltages available. It is difficult to lay down any specific rules for the guidance of one's judgment when determining whether a shop should adopt group driving or individual tool driving. These general principles, however, have been pretty thoroughly established:—

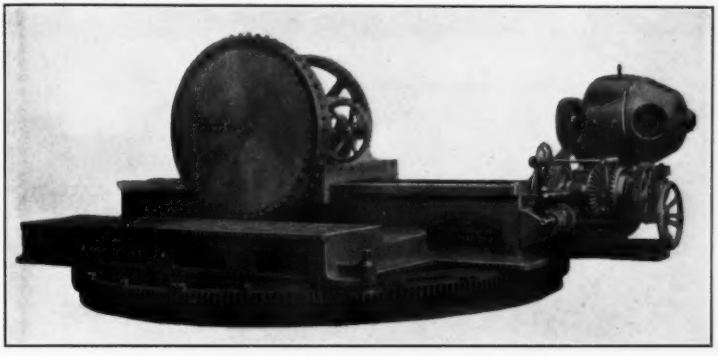
In the case of machinery running at constant speed, requiring comparatively small power for its operation, which may be compactly arranged and whose work is continuous and nearly the same day after day, it is usually best to consider first its operation in groups from short line shafts, located either above or beneath the floor and each driven by



UPRIGHT DRILL PRESS WITH DIRECT-CONNECTED ELECTRIC MOTOR.

General Electric motor, 3 horse power, 1025 revolutions, 230 volts. Drill press by Gould & Eberhardt.

a separate motor. By this method the capital account for investment in motors and accessories will be minimized, the diversity factor availed of, and power supply saved, for the economy of the drive, as a whole, will usually be higher than could be obtained by the use of individual motors. Again, maintenance and attendance are largely diminished.

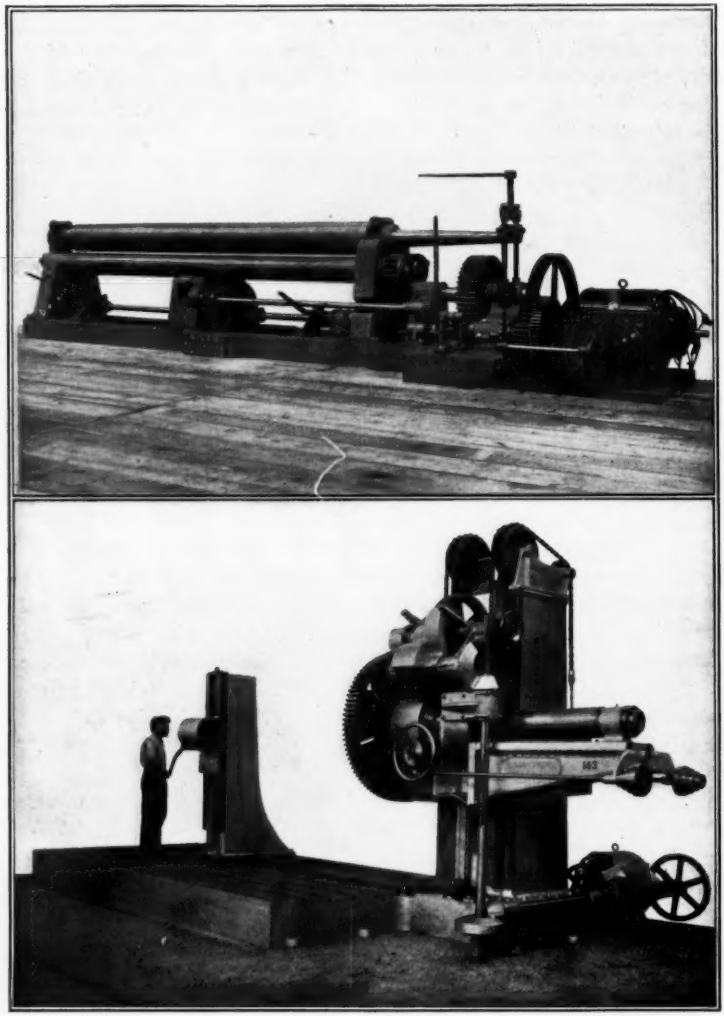


20-HORSE-POWER MOTOR GEARED TO A ROTARY PLANER.
Cleveland Punch & Shear Works Co. and Crocker-Wheeler Company.

In the case of moderately large tools requiring from one to two or more horse power for their operation, and especially in the case of tools used intermittently and subject to great fluctuations in load, or where head room for crane service, or floor space for manipulating work or the storage of stock is needed, the installation of individual motors usually seems desirable, and this is particularly true if wide variations in speed are necessary.

It is always desirable to adhere as closely as possible to the use of standard forms of motors. Such adherence on the part of a consulting engineer will tend to insure for his client motors of the highest efficiency and smallest initial cost, also better assurance of ability to obtain repair parts at short notice if they be needed at any time. In the term "standard motors," are included not only motors which are regularly listed in manufacturers' catalogues, but those semi-standard motors whose mechanical parts—frames, commutators, etc.—are standard and usual types, but whose windings may be, within limits, adapted to meet the requirements in hand.

As many machine shops have extensive wood-working departments, it may be desirable to consider briefly the equipment of wood-working tools and the power required to drive them. The quantity of

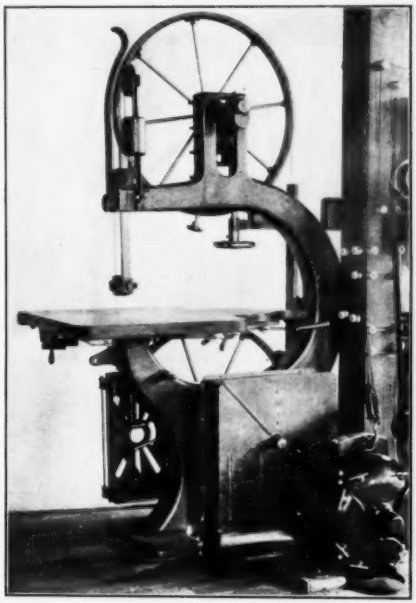


THE UPPER PICTURE SHOWS NILES PLATE-BENDING ROLLS DRIVEN BY ELECTRIC MOTOR; THE LOWER FIGURE ILLUSTRATES AN ELECTRIC DRIVEN BEAMAN & SMITH 73-INCH BORING MILL.

Electric equipment in both cases is by the Bullock Electric Manufacturing Co., Cincinnati.

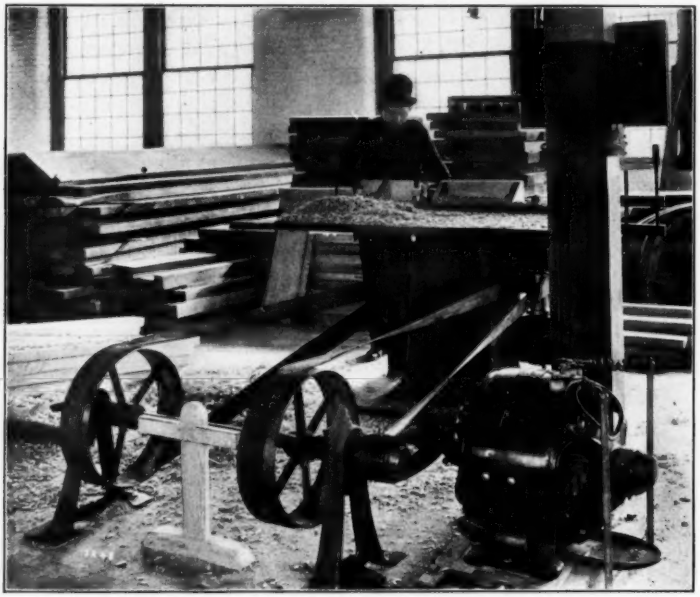
power needed to drive wood-working machinery varies greatly according to the quality and condition of the lumber used, the speed of feed, the depth of cut and, more particularly, the condition of the knives, teeth, or other cutting edges.

In this connection, it appears that one essential advantage of operating wood-working machinery by electric motors arises from the fact that a meter may be put in the supply circuit of any machine which will indicate the watts input, and a comparison of the readings thus had from time to time will show quite closely whether the machine is in good order, the feed and cut of the right amount, and the cutting edges in good condition. The importance of keeping the cutting edges of wood-working tools in good order will be apparent when it is pointed out that a given amount of work on either green or dry lumber may easily require 300 per cent. more power when the knives are dull and in poor adjustment than when they are sharp and in thoroughly good order.



BAND SAW DRIVEN BY 3-HORSE-POWER 500-VOLT GENERAL ELECTRIC MOTOR. GEAR RATIO 3 TO 1.

Electric motors are particularly applicable for the operation of wood-working tools because such tools, as a rule, require high speeds, and moderate- or high-speed motors allow the employment of the minimum quantity of belting and countershafting in their connection. Again, the power required by wood-working machines is usually much more than that needed by metal-working tools of corresponding general size, and when this large amount of power has to be transmitted through considerable belting and shafting, the losses in transmission are great in themselves. It is evident, therefore, that the expediency of equipping wood-working tools with individual motors will usually



WOOD-WORKING MACHINERY DRIVEN BY ELECTRIC MOTORS.
Shops of the Crompton & Knowles Loom Co., Phila. General Electric motors, driving by Renold's silent chain.

be greater than in the case of metal-working tools, for the elimination of high-speed belting and shafting will always be an important factor in economy.

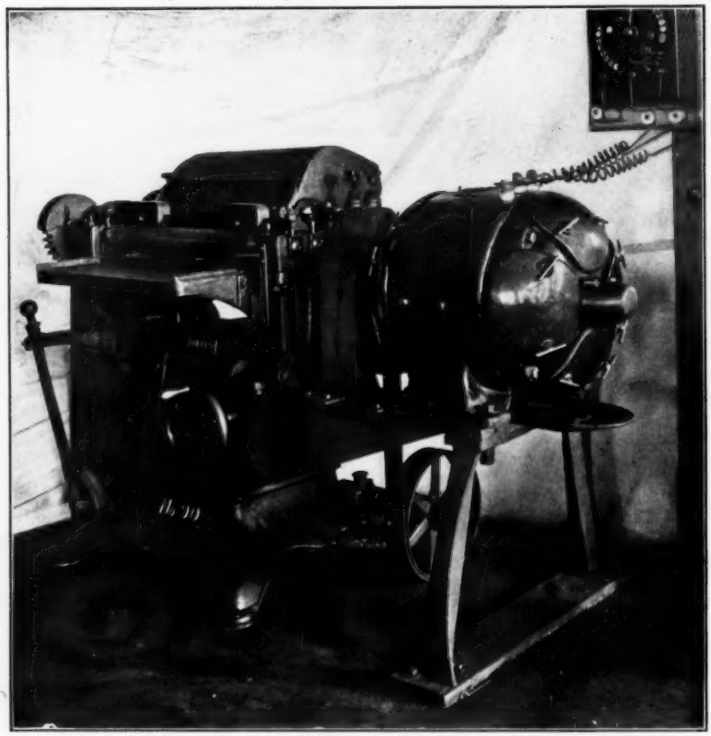
Again, the material machined on wood-working tools being larger and more bulky than the work machined on ordinary metal-working tools, the matter of minimizing the floor space has to be carefully considered. If wood-working machinery be driven from shafting, its location will not be as flexible as when driven by individual motors and, consequently the amount of floor space necessary to accommodate the machines will almost invariably be more than that needed when the individual drive is used. The investment in shafting, cost of maintenance, and loss of power therein, are also important considerations.

As the use of wood-working machinery is of a rather intermittent character, motors for operating it may usually be rated on a somewhat more favorable basis than when they are used for operating metal-working machines; i. e., wood-working tools, being run at high speed, complete their cut quickly and there is a short interval before another

piece of work can be fed in or made ready. Motors in wood-working shops should usually be enclosed—if not completely, then with gauze end-shield covers. It should not be forgotten, however, that such enclosure will decrease the horse-power output of the motor on continuous rating. The mere presence of wood dust in a motor is not particularly detrimental, but if it is allowed to accumulate and bake onto the windings or brush mechanism and commutator, then trouble will inevitably ensue. Motors in all situations should be kept clean, their oil cellars full, and the brushes well adjusted. This is not a hardship and requires but a few moments every few days if the person doing the work is conscientious and performs the duty properly. Dust should be blown out of motors by a bellows or compressed-air jet with sufficient frequency to prevent its caking up. If any oil is observed to have run along the shaft from the boxes onto the commutator or head winding, it should be wiped off. If the commutator should become rough, it must be smoothed with a piece of sand paper held over a block. If the brushes chip away or show signs of grittiness, they should be changed. Particular care should be observed that dust and oil be wiped away from the vicinity of all the terminal bushings and from the points where the brush-holder studs join the brush yoke. These matters

JOINTING MACHINE IN A WOOD-WORKING FACTORY, DIRECT-DRIVEN THROUGH A COUPLING BY TRIUMPH ELECTRIC COMPANY'S MOTOR.

seem trivial in themselves, but a proper attention to them means all the difference between the success and failure of a motor installation. Proprietors of shops will spend thousands of dollars to install an electrical equipment and then, through the lack of a few dollars spent to insure reasonable care of the apparatus, will incur hundreds of dollars in repair bills. This matter of inspection and care is of so much importance that I feel justified in giving it particular prominence here. Quality rather than quantity should be the governing feature in all service pertaining to the care of electric motors.



LIGHT SURFACING MACHINE, DIRECT-CONNECTED TO ELECTRIC MOTOR.

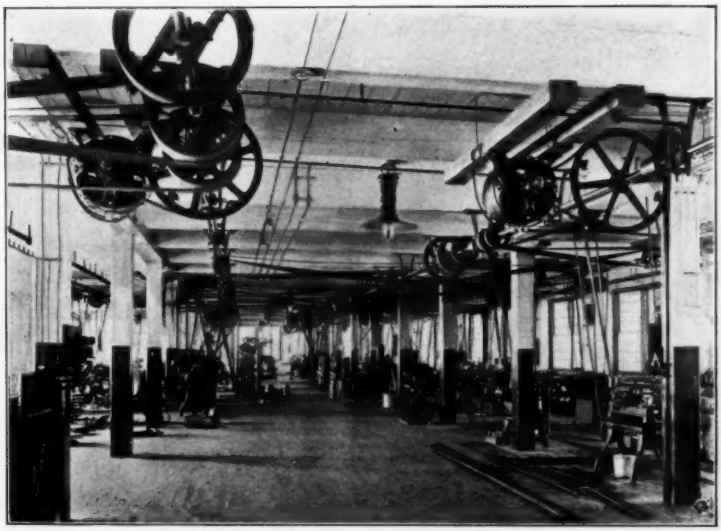
While difficult to particularize in regard to the power requirements of the various wood-working tools, the following general statements may be taken as a basis of estimate.

A direct-connected 24-inch buzz planer running at 4,000 revolutions per minute, should be fitted with a 5-horse-power motor, and this will

usually carry the cut promptly and easily through any work that is apt to be put on the machine.

A 24-inch cylinder planer running at 3,725 revolutions per minute will require about 7½ horse power on dry stock and 15 horse power on unseasoned rough lumber.

Irregular double-headed moulders require from 1½ to 2½ horse power per head.



GROUPED MACHINERY IN THE SHOPS OF THE CROMPTON & KNOWLES LOOM CO., DRIVEN BY GENERAL ELECTRIC MOTORS THROUGH RENOLD'S SILENT CHAIN.

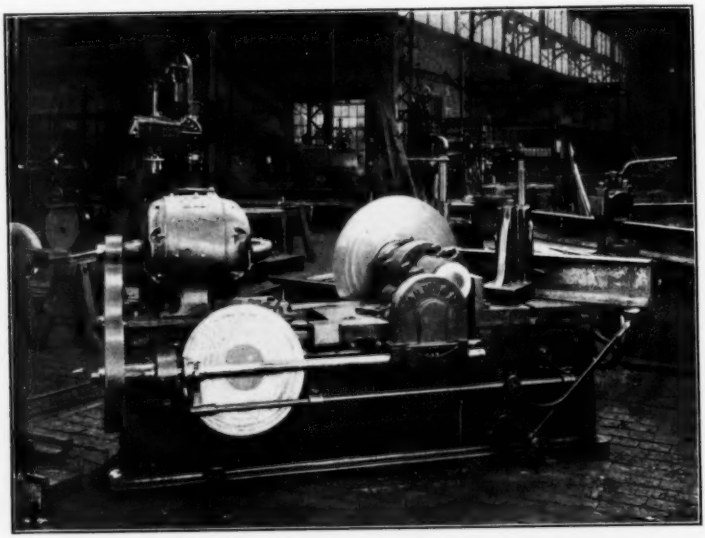
Sticking machines require rather heavy equipments. A four-sided sticking machine of average size will usually require a 10-horse-power motor.

An 8-inch circular rip saw on heavy work will require form 1½ horse power to 2 horse power. A similar amount of power will be required for a similar size cut-off saw.

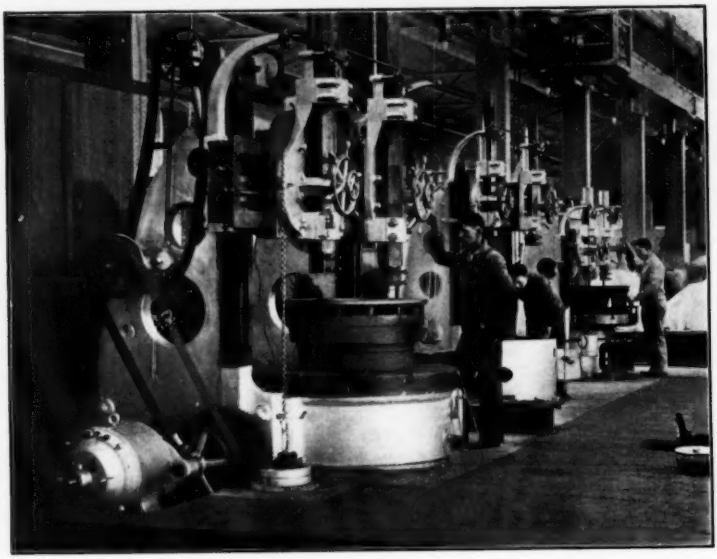
A 12-inch cut-off or rip saw will require about 3 horse power. An 18-inch cut-off or rip saw will require 5 horse power.

An ordinary band saw will require about 2½ horse power, while an ordinary jig saw will require about 1 horse power.

The above ratings assume that the tool is in good adjustment, with cutting edges in fair condition, and that the feed and cut will be as heavy as is consistent with smooth work.



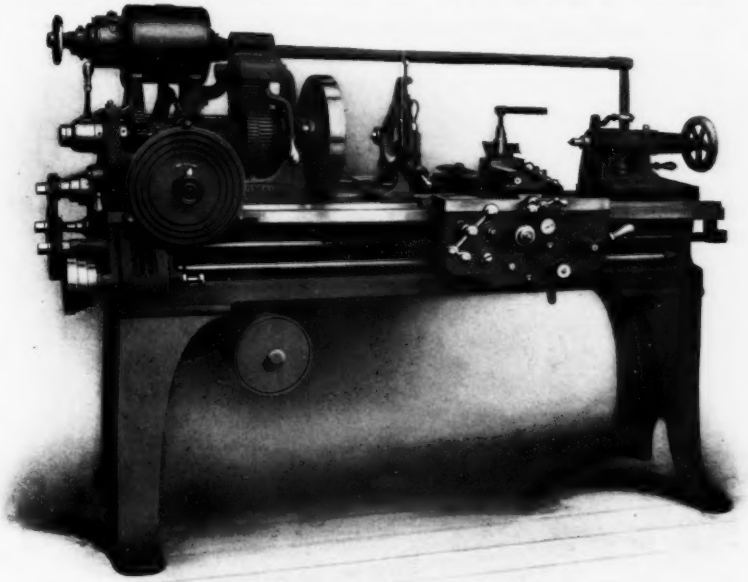
NEWTON COLD SAW DRIVEN BY GENERAL ELECTRIC MOTOR.



GROUP OF NILES BORING MILLS DRIVEN BY BULLOCK MOTORS.

The choice of motors and grouping of machinery affords a field for the exercise of unusually good judgment. As an illustration of the difference from a financial standpoint between two methods of equipping a shop, let us investigate a typical case based on and combining actual experiences.

A wholesale furniture dealer, owner of a four-story storage building, uses the top floor for the manufacture of light woodwork. The building contains a freight elevator and on the top floor are installed

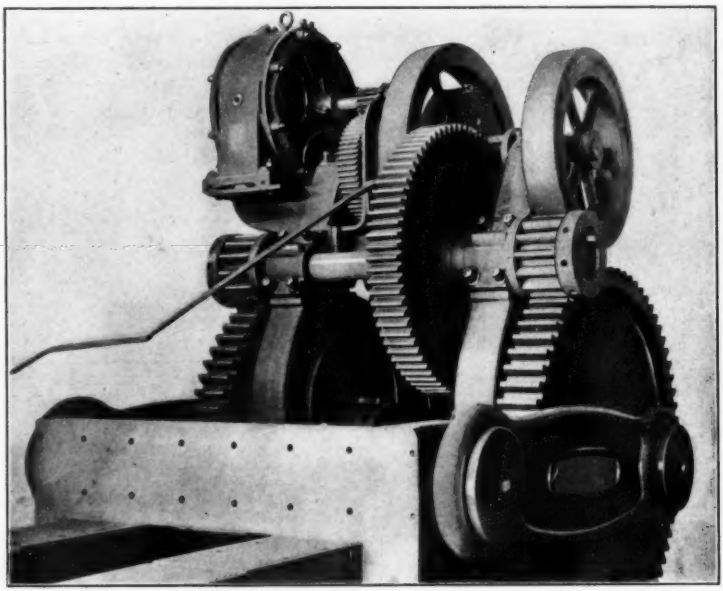


MOTOR DRIVEN LATHE, WITH THE ELECTRIC MOTOR MOUNTED ON THE HEADSTOCK AND GEARED TO LIVE SPINDLE. STOREY MOTOR AND ELECTRIC COMPANY.

two "Weymouth" wood-turning lathes, one buzz planer, one circular saw, and some other small special machines, the power requirements of which are so small as to be negligible. The lathes are in constant operation and the requirements of the work such that either the planer or the saw is always in operation also. The elevator is on the street front, which happens to be the darker end of the building, and the work done on the shop floor, requiring good light, necessitates the location of the machines in the opposite or rear end of the building. The elevator machinery is on the top floor and the motor near it. It is

necessary to run a line shaft the full length of the building in order to supply power to the shop, and to distribute the power properly and avoid too much handling of the work, some additional light shafting is also needed.

A 15-horse-power, moderate-speed motor having been selected for power supply, it is found, after a few months' trial, that the current bills average nearly $5.00 a day; although the owner of the business is only paying 6 cents a kilowatt for current, he considers the total bill excessive. After an investigation of the conditions obtaining in his factory, certain changes are made much to his benefit. It is found that the elevator requires practically 7½ horse power to operate it, that its average use is two hours a day, and that when used it is ordinarily fully loaded. The two "Weymouth" lathes are found to require



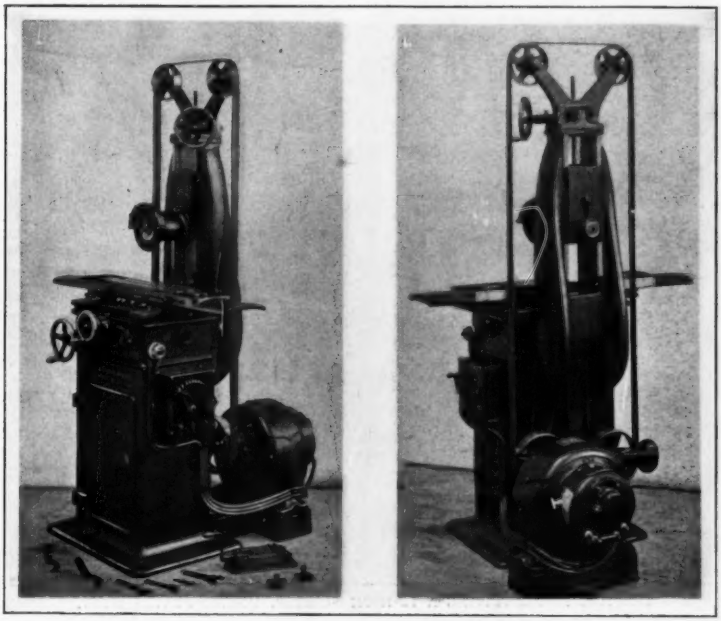
ELECTRIC DRIVEN "BULLDOZER."

Williams, White & Co., Moline Ill. Westinghouse alternating-current motor.

1 horse power each, as the work done on them is small, light, and uniform. The average requirements of both the buzz planer and circular saw are found to be 3 horse power each. The friction load on the high-speed line shaft for driving the wood-working tools, including the long and heavy belts to the elevator mechanism, is 2½ horse power,

and when everything is in operation, the 15-horse-power motor is just fairly loaded.

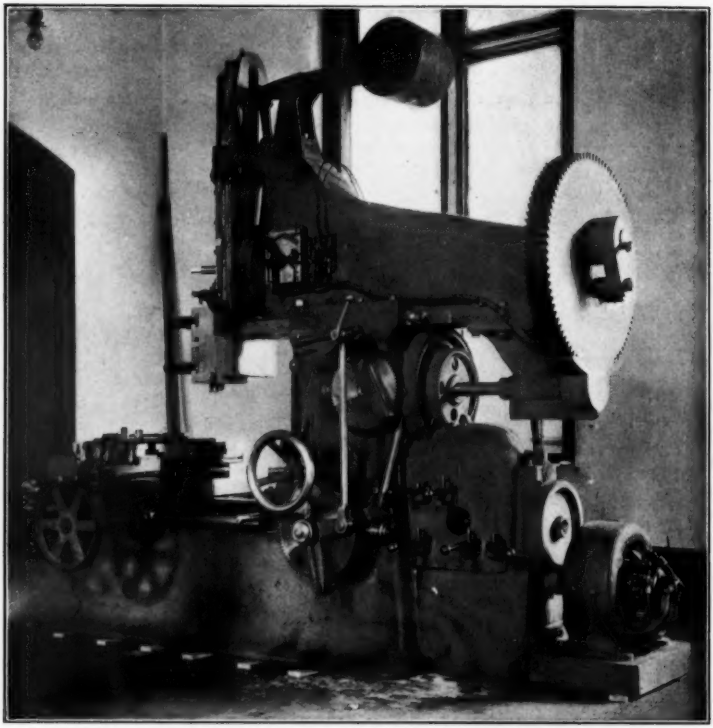
During the eight hours of the day, however, when the elevator is not at work, the motor is only about half loaded, and of the load it then carries, one-third is the friction loss before mentioned.



BROWN & SHARPE SURFACE GRINDING MACHINE DRIVEN BY 1-HORSE-POWER 230-VOLT GENERAL ELECTRIC MOTOR.

A change in motors and a re-arrangement of tools is made, the 15-horse-power motor being replaced by a 7½-horse-power slow-speed motor for driving the elevator mechanism, a 3-horse-power moderate-speed motor for driving the planer and saw, and a 2-horse-power moderate-speed motor for driving both lathes. The small special machines take the insignificant amount of power needed from the 3-horse-power motor. The long line shaft and all but two very short lengths of distributing shafting are cut out, as the 7½-horse-power motor is set close to the elevator mechanism.

The result of this change will give an average saving of $1.34 per day, or $415.40 a year of 310 working days. The 15-horse-power motor running under full load with an efficiency of 88.2 per cent. two



ELECTRIC MOTOR DRIVING A 12-INCH SLOTTER, UNITED STATES MINT.
T. C. Dill Machine Company and Crocker-Wheeler Company. The motor is 3-horse-power. Different speeds secured by gear changes.

hours per day would entail a charge of $1.52; during the remaining eight hours when it ran on half load at 81 per cent. efficiency, it would use $3.32 worth of current—a total of $4.84 per day. By making the suggested change, the 7½-horse-power slow-speed motor would work two hours a day at full load with an efficiency of 86.5 per cent., and the current charge would be 78 cents; the 2-horse-power motor would run ten hours a day and at full load with an efficiency of 81.9 per cent., and the current charge would be $1.09 per day. The 3-horse-power moderate-speed motor would operate 10 hours a day at full efficiency, 82.2 per cent., with a current charge of $1.63—making a total for the three motors of $3.50 per day.

The saving, therefore, resulting from the change in equipment would be $1.34 per day or $415.40 per year.

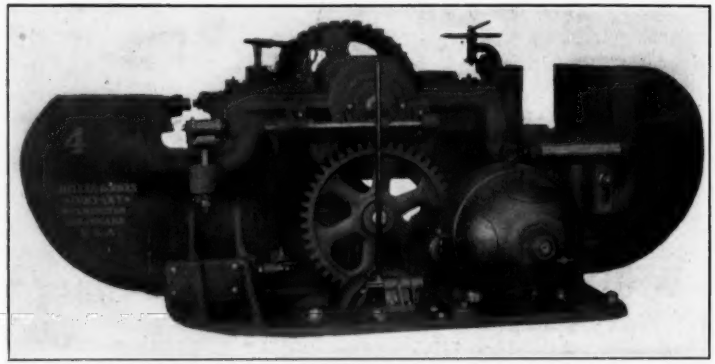
Suppose the 15-horse-power motor originally cost $295. The motors purchased in its place would have cost about $425, or $130 more than the single machine. It will be observed that the saving in current would nearly pay for the three new motors in the first year; if the difference in prices between the 15-horse-power motor and the three smaller motors—i. e., $130—had been paid originally, the owner would have enjoyed a net gain of $285.40 at the end of the first year, or the interest on an investment of $5,700 at 5 per cent. The re-arrangement would not only result in financial saving but do away with the maintenance and inspection of the shafting and thereby reduce the danger from fires due to overheated boxes, and the wear and tear of long belts.

As long as the 15-horse-power motor was in operation, the owner would not only be paying for all current really needed, but losing an additional sum of money which, if capitalized, would be equivalent to an investment of $8,300 for his motor, a sum which, if to be spent at once, he would not have thought of paying.

The saving of $415 a year would not only nearly purchase a complete new equipment of motors every year if needed, but as the average life of a motor, conservatively estimated, is at least ten years and repairs may be figured at 5 per cent., at the end of ten years all the motors could have been replaced and a cash balance of some $5,000 realized, if the savings had been banked from time to time, at 4 per cent.

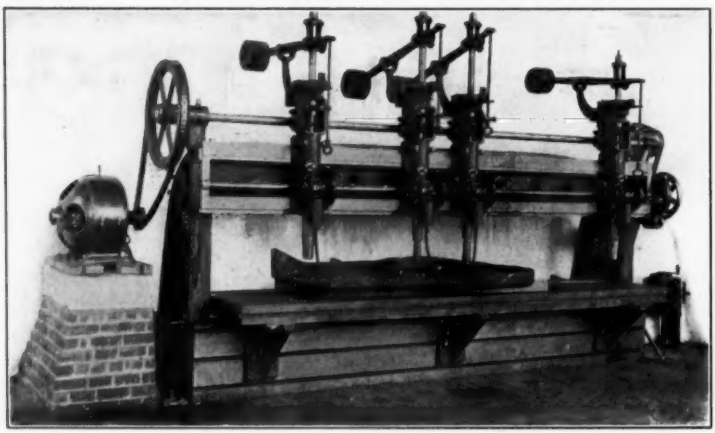
Motors on individual tools should be mounted over the center of gravity and as near the base of the tools which they serve as possible. They should also be fully protected from chips, oil, and the possibility of mechanical injury. Simplicity of connecting drives should always be aimed at. Brass-shrouded rawhide pinions, working in steel gears, are usually satisfactory. The use of the Renold "silent chain" also affords a very satisfactory method of transmitting power from the motor to the moving parts of machines.

The application of motors to machine tools having a reciprocating motion, such as planers, shapers, and slotters presents some difficulties of special importance. Instantaneous and frequent reversal of a motor should be avoided, as much as possible, on general principles. A suitable gear train may usually be availed of to give reverse motion, the forward or return stroke of the tool being governed by electric clutches or other suitable devices. When a motor is to be subjected to violent and sudden changes in load, a flywheel on the armature shaft will often be of great advantage in preventing shock to the armature and thus minimizing sparking and cutting at the commutator.



MOTOR APPLICATION TO PUNCH AND STRAIGHTENING PRESS.
Hilles & Jones Company tool, Crocker-Wheeler 15-horse-power motor.

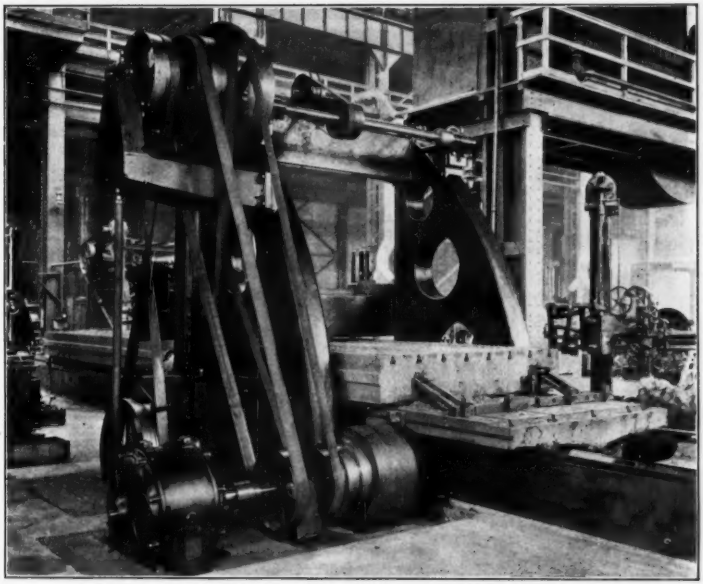
It is desirable to insulate the motor from the frame of the tool when this can conveniently be done. The insulation should be of most excellent quality, however, proof against water and oil, and of such character as to keep its shape and rigidity under all conditions. Great care should also be taken to protect the motor terminals and the wiring system from possible contact with the workmen operating the tool. The various tubular conduits made by the Sprague Electric Co. of New York seem especially well fitted for enclosing the wiring on machines. An effort should be made to locate all controllers and



ELECTRIC DRIVEN MULTIPLE-SPINDLE DRILL, L. S. & M. S. RAILWAY SHOPS, COLLINWOOD, OHIO.
Niles tool and Crocker-Wheeler 7½-horse-power motor.

switches so that they will be very accessible and convenient to the workmen. They should also be enclosed or semi-enclosed in such manner that all metallic portions carrying current are fully protected.

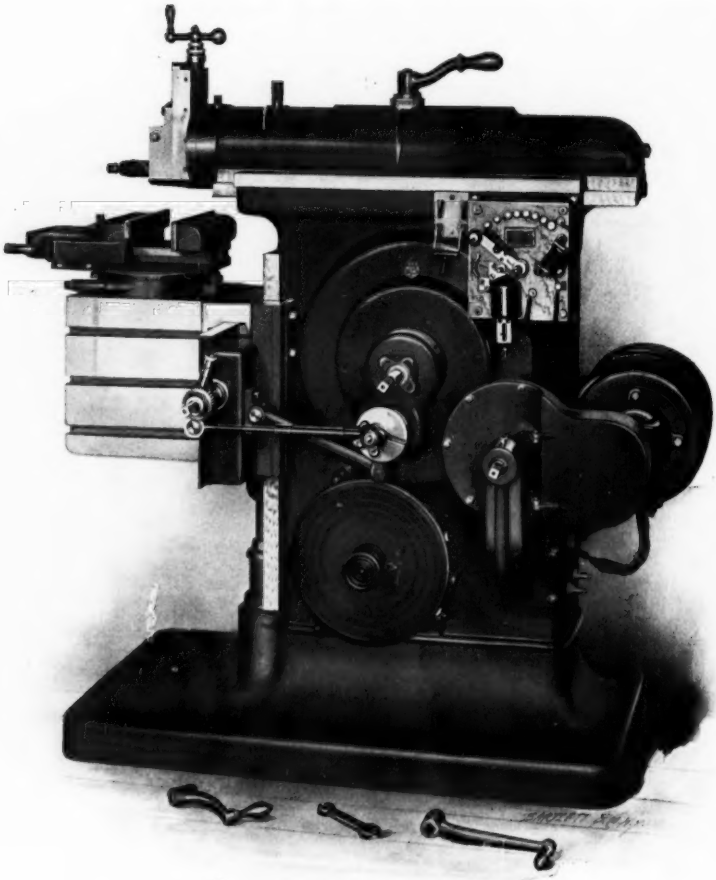
In laying out a line of new machine tools, it is a comparatively easy matter for the designer to make all necessary arrangements for attaching the motor which he proposes to use. Planing bosses, pads, or brackets may readily be incorporated into the design of the machine.



HEAVY PLANER OPERATED BY ELECTRIC MOTOR. WORKS OF NEW YORK SHIPBUILDING CO., CAMDEN, N. J.

30-horse-power Westinghouse alternating-current motor. Planer by Betts Machine Co., of Wilmington, Delaware.

As there are, however, a great many thoroughly good and satisfactory tools in use, which the owners would not care to cast aside for modern self-contained motor-driven tools, it is often necessary to provide motor supports on machines already in use. Skeleton brackets and other structures made from "channel," "T" and "I" beams may often be advantageously employed. In a number of cases low sub-bases have been made, on which the tool and its motor were both assembled, and the drive effected either by belt, chain or gears. In such cases the complete motor-driven tool may often be transported from place to place by an overhead crane and landed wherever it can most advan-



STOCKBRIDGE SHAPER DRIVEN BY ELECTRIC MOTOR.
Storey Motor and Electric Co.

tageously be used, current being brought to it by means of a cable connection from a wall outlet.

When supporting brackets and pads have to be secured to the frames of tools already in use, a very satisfactory method of fastening them without the necessity of planing or dressing the surfaces to be joined is to drill and tap the machine frame for such pads or brackets as are needed and then fasten them approximately in place with cap

screws. When they have afterward been lined up by means of small wedges, the joint may be dammed with putty or clay and hot type metal poured in the opening to make a seat. After the type metal has cooled and the cap bolts are tightened up, it will be found that a very substantial and satisfactory support for the motor has been obtained.

When motors are mounted on machine tools and transmit their power by short belts, provision should always be made—unless an automatic belt tightener is used—to rock the base, on which the motor rests, by a compound lever or screw in such manner that the tension may be quickly thrown off the belt if necessary.

When short line shafts are used to distribute power, it seems desirable to adopt some one of the anti-friction hanger boxes. There are two or three varieties of interchangeable boxes now on the market which may be used for decreasing friction in shafting hangers with excellent results. It should always be remembered that it costs a great deal of money to keep pulleys, shafting and belting in motion, especially if the overhead works are heavy and considerable power is being transmitted. In a recent case, for instance, it was found that the cost of operating one line shaft in a small shop was about $1.46 per day, or $452.00 per year. The use of an approved variety of non-friction boxes would have undoubtedly reduced this loss very materially.

Even in an engine-driven shop there are often isolated machines which are used intermittently that might be operated to better advantage and at less expense by motors taking their current supply from a central station even, than by belt and shaft transmission, such transmission often requiring an expenditure in belting and shafting, and operation and maintenance of the same, that would more than compensate for the cost of a motor and its installation.

When the product of a shop consists of articles so heavy that crane service is needed for practically all of the machines, it is rarely possible to use group driving, and in such a case the gains, arising from the possibility of universal crane service, will often more than compensate for the extra cost of equipping a large tool with its own motor, and it may also be pointed out that in such shops the power requirements of the tools usually demand a moderately large motor, with variable speed control, in any event.

While it is desirable to keep efficiency of operation and saving of power always in mind, the real and final object to be sought is maximum production with a given investment in machinery and buildings. Hence, as the cost of power alone is always relatively small, one would

NORTHERN ENCLOSED 3-HORSE-POWER MOTOR DRIVING A FOUNDRY TRUCK.

The arms at the left are inserted under the pots of melted metal and raised by an eccentric so the truck wheels take the weight. Motor operates through gears (as shown) to move the truck at the will of the operator. The controller handle is seen over the swivelled wheel at the right. The reel carries the wire conducting power to the truck.

be perfectly justified in using a rather inefficient motor or drive, in an exceptional case where it fully met some special requirement and enabled production to be largely increased.

In general the savings to be derived from the use of the electric drive will not be so apparent in the saving of power measured in or expressed by its direct money value simply as in the utilization of wasted power to productive purposes. From 2 per cent. to 5 per cent. of the cost of the product made in a large average shop may be in power. A saving of 10 per cent. in this item alone is comparatively trivial when compared with the gains to be derived from a 10 per cent. increased production due to the utilization of power formerly wasted.

The demand for motors and motor-driven machines is increasing at a marvellous rate, and every reputable manufacturer of such products is operating his works at the fullest capacity. Distribution of power by electricity holds first place, and progressive manufacturers throughout the world are now fully committed to its use. The preliminary and missionary work has practically all been done, and builders have only to produce and offer sturdy and efficient motors and motor-driven tools of suitable design to reap the rich harvest which is just now ripening into full maturity.

PURCHASE BY THE ORGANIZED FACTORY.

By Horace L. Arnold.

The article below is the converse and supplement of the cost-keeping series which have attracted so much attention in these pages in the past. They dealt with the systematic knowledge of the output of the shop. This treats of the systematic knowledge and control of the material coming into the shop.—THE EDITORS.

PURCHASE by the unorganized factory, owned and managed by a single individual, is a simple matter. The manager probably has his regular source of supply, and perhaps has a standing order there, and so merely files the invoice when it comes in, or if he is very old-fashioned, has his book keeper copy it at length in his invoice book. The factory foreman or superintendent or the teamster may report receipt of material, and the manager may himself inspect it into the factory. The book keeper may have an account with invoices payable, or may not, and the check to satisfy the invoice may, and probably will, reach the vendor at the expected date. The material itemized on the invoice may go to the factory stores, and be entered in the stores-room ledger, which is pretty certain to be a book, (and also pretty certain to be a source of private doubt on the part of the stores keeper), or it may go directly "onto the job," without any receipt whatever from the factory to the counting room.

Quite likely the order is in excess of the expected demand—"Better have enough, so as not to have to order twice"—and it is not impossible that in spite of the excess received, there may be a shortage in the factory before the job is ready for shipment. Such things have been known, even in very well managed shops, and form a part of the daily trials and vexations in many shops which, after all, pay their way and make good work. When the shortage is discovered, at the last minute, perhaps, there is a sixes and sevens discussion. If the teamster inspected the stock into the factory he vouches the correctness of his report, which is generally reliable in proportion to his illiteracy, the man who cannot make a written record commonly having a tenacious memory of the few facts he impresses on the comparatively blank pages of his mentality. If the owner or superintendent inspected the material into the factory, then all certain trace of it is hopelessly lost. The owner is not sure, the shop head is not sure, and

all the workmen in the place have had access to the material in dispute for days or weeks or maybe months. If the material went into the stores room and was recorded on the stores ledger, and was formally requisitioned out by the "department of production," then the case is more narrowly defined in form, but not in fact. The owner does not question the honesty of the stores keeper, because he knows him well, but the stores keeper cannot show the material, the factory foreman is sure he requestioned into the factory only what was required, the boss of the assemblers knows he never had any "over" parts, and after much turmoil of a wholly unprofitable nature, all hands conclude the only thing to do is to order more material, and have it in the factory as soon as possible.

The sequel to this comedy or tragedy of the missing purchase may be a resolve on the part of the owner to "fix things" so that no such muddle will ever occur again, and if he knows how some other factories make purchases and receive and store and disburse material, and keep track of that material in its journey through the factory departments right up to the shipping room and bill clerk and transportation receipt, this perturbed owner may really make an attempt to know what he buys and pays for, and where it goes to.

Stores may be missed in any factory, or bank either, for that matter, or from any express company's iron box on a fast train, or from the strong room of a swift steamer, or the privacy of the dwelling, or from the final crypt itself, where the weary are at rest; but in the organized factory two things are certainly present in case of materials received by the factory. First, some one makes a sure record of the receipt of materials, to satisfy either all or part of the invoice as received, and the stores keeper holds somebody's receipt for all of his disbursements, unless the stores room has been looted.

The modern factory organizer reverses the proverbial injunction first to catch your hare, and provides a place to keep the hare safe and in good condition before it reaches the factory. The stores room is the factory name for this place or apartment where purchases are received and stored, and the stores room may be any structure whatever, or no structure—simply a yard, unroofed—and is often a shed, and often a wire-netting-enclosed division of the main factory floor. The stores room is usually operated with locked doors, which might possibly be clock-actuated. It may have stores receptacles of any sort, and stores records kept in books or on cards.

The factory organizer is not always strictly orthodox in his personal views of the world to come, but so far as this world is concerned

DATE		MATERIAL	QUOTED BY	PRICE	TERMS	REMARKS
Nov	6/02	Steam gas water pipe	Allen & Reed	1 ft 60%	usual	Job Prov.
"	"	"	"	2 ft 6 in 67½	"	"
"	"	"	"	4 ft 6 in 12 65	"	"

PATENTED MAY 28, '01 — LIBRARY BUREAU, A468

FORM I. PURCHASE AGENT'S QUOTATION CARD.

5 by 3 inches, ruled in red, blue, and black. Filled by agent from correspondence or other information, and filed alphabetically by stores-room designations. Each card refers to a single article. Old cards are destroyed as they are replaced by newer ones. Filed in cabinet on purchase-agent's desk.

he invariably turns to Scripture for his guiding text, and declares with inexorable pessimism that no one man can safely be relied upon to give an infallibly correct narration of occurences, and that "in the mouth of two or three witnesses shall every word be confirmed." So the organizer places two men in the stores room, the receiving clerk and the stores keeper and disburser, and provides a card stores ledger, and is then ready to buy stores, as he has a place to put them in and men to receive and hold them.

Purchase Quotations:—Before the factory can make a purchase it must know who can sell the required material. The old-fashioned office buyer kept his book of tenders. The new factory purchase office keeps a card file of quotations, in a cabinet, usually in easy reach of the left hand of the purchase agent. A well devised quotation-card form, partly filled, full size, is here given as used by the Cottrell purchase agent.

The purchase agent must have a place where he can write, and he can use several other aids in his work, but he need not occupy much room. Having provided what is necessary, the factory organizer is ready to install his purchase agent, whom he selects with care to secure intelligence and avoid delays. He does not expect him to avoid errors, but he so plans and arranges his purchasing forms and procedures

that all mistakes should be discovered before the error can leave the hands of the man who makes it.

Who May Request a Purchase:—Obviously any head of a department, or any leading workman, for that matter, may be the first one to know that the factory is in need, and so may be the proper person to ask the stores keeper if he has the requirement on hand. Suppose that he has not; then the stores begin the process of replenishment by sending Form 2, blue, filled by the stores keeper, to the "Department of Plant." The head of this department of plant, or general factory superintendent, then approves and vitalizes Form 2 by filling the "Ordered From" space and standing order number, and then, after

Purchase Order	Department	Date 190
Quantity	Description	
Order From		
Purpose	S. O. No.	Wanted by what date
Required by		Approved
C. B. COTTRELL & SONS Co.	REQUISITION FOR PURCHASES	

FORM 2. DEPARTMENTAL PURCHASE REQUISITION.

5¾ by 3¾ inches. Ruled in black on pale blue paper.

singing his name in the "Approved" space, places it in the "out" basket on top of his desk, whence a constantly itinerant messenger soon conveys it to the purchase agent.

It will be observed that the purchase authorization must come from the head of department of plant, who is the supreme factory ruler. Others may inform the autocrat of the needs of his domain, but he alone can fill them. The volition and discretion of the purchase agent extend only to an examination of sales agent's samples, and a recommendation of them if satisfactory to him. If satisfactory also to the department of plant, then the quotation goes on the proper card,

PURCHASE ORDER No._____
PRICE CORRECT_____
EXTENSION CORRECT_____
QUANTITY CORRECT_____
VOUCHER NUMBER_____

FORM 3. RUBBER STAMP IMPRESSION. Full size. Printed in red on the face of every invoice received by purchase agent, who fills first three spaces. The last two are filled by head of department of plant.

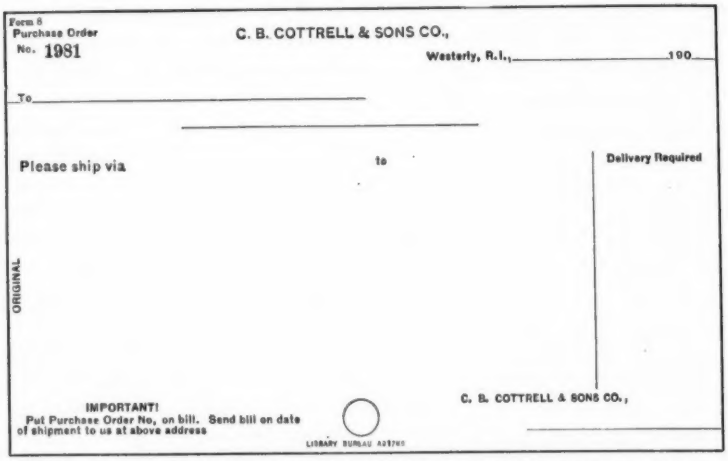
and the purchase agent can select his vendor, unless he is directed where to place the order.

Making the Order:—So far, only one written specification of the proposed purchase has been made by filling Form 2. This must not leave the factory because it tells what is wanted, what the wanted thing is wanted for, who wants it, and because it records the approval of the department of plant, and so authorizes the purchase agent to order the material sent to the factory. Hence there must be one more paper written, and this paper must perform many functions. First it must order the vendor to make the shipment of his wares to the factory. This will bring the material to, say, the factory door; then the department of plant, or factory superintendent, must be informed of this arrival, correct weight and condition certified. The store's receiving clerk will fill some kind of a form blank to say that he has received certain articles in good condition. The purchase agent must also be notified of the arrival of the order at the factory. To save clerical labor, and to keep the total number of form blanks as low as possible, the order to the vendor is made on a blank form so devised that this letter, which is to be sent away from the factory by mail, may be filled in carbon-copy duplicate and triplicate, all certainly alike. Obviously these three documents, the original and the two carbon copies, should bear the same number. Obviously, also, there should be some distinguishing difference between the three documents, which are identical in wording.

To meet all these requirements, Forms 4, 4 A, and 4 B, which see, are provided, and when the purchase agent receives an order on Form 2, he has only to turn it over to his typewriter, who proceeds to take a white Form 4, and yellow Form 4 A, and a blue Form 4 B, all identical in size and printing, and write the three at once in original, carbon duplicate, and carbon triplicate, and then returns Forms 2, 4, 4 A and 4 B to the purchase agent, who compares 4 with 2, and

_____ to S. O. No. _____
_____ to S. O. No. _____
_____ to S. O. No. _____

FORM 3 A. RUBBER STAMP IMPRESSION. Printed in red by purchase agent on the face of every order received. Standing-order spaces are filled by him from his yellow Form 4 A.


Form 8
Purchase Order
No. 1981

C. B. COTTRELL & SONS CO.,

Westerly, R.I., 190

To

Please ship via

to

Delivery Required

ORIGINAL

IMPORTANT!
Put Purchase Order No. on bill. Send bill on date of shipment to us at above address

C. B. COTTRELL & SONS CO.,

LIBRARY BUREAU A37M1

FORM 4. PURCHASE ORDER. FORMS 4 A AND 4 B ARE SIMILAR, EXCEPT IN COLOR.

7¾ by 4¾ inches, thin white paper. Form 4 A is yellow, and bears the word "Duplicate" in place of "Original," at the left. 4 B is blue, and is marked "Triplicate." All are filled by purchase agent simultaneously, by carbon copy. Form 4 (white) is sent to mailing clerk, and forwarded by him to the seller supplying the goods ordered. The purchase agent retains the yellow duplicate for record; the receiving clerk gets the blue triplicate to verify the goods received.

if correct, signs 4, 4 A and 4 B, and then sends white Form 4 to the mailing clerk, blue Form 4 B to the receiving clerk in the stores room, and files the yellow Form 4 A in a temporary "waiting tray."

Form 2, having served the several purposes of notifying the department of plant of factory need, and conveying the department of plant's order to fill that need to the purchase agent, and having dictated the letter to the source of supply which is typewritten on Form 4, has now performed all of its regular functions, and is sent by the purchase agent to the department of plant and filed in the card cabinet drawer marked "unfilled orders," there to remain as an available witness to all the procedures preliminary to the mailing of the purchase order. At this period the purchase agent has a yellow copy of the order in his "waiting" tray, and the receiving clerk has his blue triplicate in a "waiting" file in the stores room, and knows that he may expect the ordered material at about a certain future date.

It will be observed that Form 4 has printed in its lower left corner, "Important! Put purchase order No. on bill. Send bill on date of shipment to us at above address."

The vendor is bound by commercial courtesy to obey this injunc-

tion, and consequently an invoice bearing the purchase order number reaches the factory either before or with the first delivery of material on the order. This first shipment invoice may only partly cover the order. In any case the invoice goes to the purchase agent, who stamps it on its face with rubber-stamp impressions of Forms 3 and 3 A, which see, and fills the first three spaces of Form 3, and the order number spaces in Form 3 A. A single invoice may be divided into allotments to different standing order numbers. After this receipt, price, extension, and standing order certifications by the purchase agent, the invoice goes to the department of plant, where the fourth space of Form 3 is filled from 4 B, and the 5th space of Form 3, "Voucher Number" is also filled. The fourth space of Form 3, "Quantity correct," is filled by department of plant from certification by the receiving clerk, who upon receipt of material compares it with his blue triplicate Form 4 B, and if the order is completely filled, makes and signs a certification of quantity and condition on Form 4 B, and then sends it to the department of plant. In case the material received only partly covers the order, then the receiving clerk notes this receipt of material on Form B, and makes a statement of receipt on Form 10, interdepartment correspondence blank, a plain bond-paper sheet 7¾ by 5 inches headed "Subject ...." "To ...." and forwards Form 10 to the purchase agent, who notes receipt of material on his yellow Form 4 A, and then sends Form 10, bearing the receiving clerk's "Materials Received" and signature, rubber-stamp impression, to the department of plant.

The receiving clerk, after noting the partial receipt of the order on his blue Form 4 B, returns it to his "waiting" tray, and holds it there until he receives material to satisfy the order fully, before sending Form 4 B to the purchase agent, and, through the purchase agent, to the department of plant. Thus the department of plant is informed by the nature of the form used for communication from the stores receiving clerk as to whether the materials received wholly or only partially satisfy the order number which is borne by the invoice. If the delivery is partial, then the Form 10 bearing the order number is filed with the Form 2 bearing the number, in department of plant cabinet drawer marked "Unfilled Orders," and held there until blue Form 4 B of that purchase order number is received from the receiving clerk, thus certifying the complete receipt of the order by the stores room. The notifications on Form 10 are compared with the invoices bearing that order number, and everything being found correct, the department of plant sends the invoice to the cashier.

So far the factory is safe, as it has the ordered material under lock and key. The factory is also fully informed, since every official who should know the story of the order has a full written history of the transaction. The stores keeper made the order notification or requisition to the department of plant on Form 2; the head vitalized, and finally filed it in his cabinet. The purchase agent on authority and transcription from Form 2, wrote the letter ordering shipment from vendor, at the same time making carbon duplicate and triplicate with the one writing, the original being the letter sent away, the yellow duplicate being the purchase agent's own filed story of the order, while the blue triplicate goes to the stores receiving clerk, and is filed in the stores room, where the transaction began its record on Form 2. It will be observed that each human factor in this complex act of purchase ordering holds a copy of the work for which he was mainly responsible, and that while only two form originals have been filled, the vendor has been advised as to shipment, and four functionaries of the factory hold written histories of the transaction in detail. All of this is admirable; nothing wasted, and records filed in factory departments wherever useful.

The purchase voucher is made out on Form 6. This form is filled by the cashier from invoices received from head of department of plant; the invoice is then filed alphabetically in the unpaid invoice file in the cashier's room. Each vendor has an individual Form 6 filled for each month, and a check is made each month to satisfy the totals, the check being printed with "In payment of Voucher No.," followed by a space filled with the Form 6 number. If this check is cashed the account is satisfied. (See advices at foot of Form 6 A.) Form 6 is totaled and dated at the end of each month and placed on the unpaid file. Where invoices are paid oftener than monthly, to obtain early payment discounts, a separate voucher is made for each due date and check, covering invoices from date of last check. Checks are drawn to satisfy unpaid invoices at stated periods, or at order of head of department of plant, who alone signs checks.

When Form 6 is filled down to the certification space, it is sent by the cashier with invoice or invoices to the office manager, whose desk is in the department of plant, who compares the filling with the invoice totals, and certifies correctness by his signature, returns invoice or invoices to the cashier, and sends the certified Form 6 to the head of department of plant, who authorizes the drawing of a check to cover, by writing his signature in the "Approved" space, and then returns Form 6 to the cashier, who writes the check and sends check

PURCHASE VOUCHER No.	Name / Address					Account No. / Date Issued		
Dates	Amounts	Deductions	Dates	Amounts	Deductions	Account Distribution		
						a/c Nos.	Account Titles	Amounts

I certify that the above account is correct, and that the amount is vouched for by invoices regularly approved by the duly authorized persons.

Office Manager

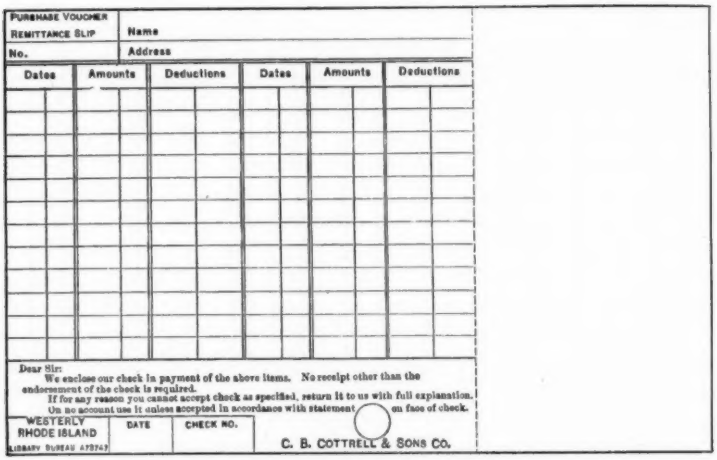
	Date Paid	Check No.		Approved
			LIBRARY BUREAU A78747	Treasurer

FORM 6. PURCHASE VOUCHER.

7¾ by 4¾ inches. Ruled in red and blue and printed in black.

and voucher to the department of plant, where the head signs the check. Then Form 6 and the check are returned to the cashier, who applies the "check-protector" stamp "Not over" the nearest $10 excess, to prevent check raising, and the check then goes with Form 6 A to the mailing clerk. When Form 6, approved, and the invoice or invoices, are returned to the cashier from the department of plant, the cashier stamps the invoice or invoices "Paid" with a rubber dating stamp, and files the invoice by the "vertical file" system, which keeps each firm's correspondence separate. Form 6 A is finally filed alphabetically in a "Paid Voucher" tray, in the cashier's room for reference as required.

While it takes a great deal of space to show these purchase and purchase payment forms, and to specify exactly all of their functions and resting places, temporary and permanent, the forms themselves are very small and simple, and very easily filled by clerks of ordinary qualifications. No one person can alone perform any of the important functions of purchase order and payment. Several persons must be informed, and join their efforts to order material delivered to the factory, and the issuing of a check must also be the work of several persons, including the two of greatest responsibility, the head of department of plant, and the general office manager. Of the two, the purchase is less complicated than the payment: this is commercially



PURCHASE VOUCHER
REMITTANCE SLIP

No.

Name

Address

Dates	Amounts	Deductions	Dates	Amounts	Deductions

Dear Sir:
We enclose our check in payment of the above items. No receipt other than the endorsement of the check is required.
If for any reason you cannot accept check as specified, return it to us with full explanation.
On no account use it unless accepted in accordance with statement on face of check.

WESTERLY
RHODE ISLAND

DATE

CHECK NO.

C. B. COTTRELL & SONS CO.

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FORM 6 A. PURCHASE VOUCHER REMITTANCE SLIP.

7¾ by 4¾ inches, ruled in red and blue and printed in black. Filled by carbon copy when Form 6 is made out, and filed with Form 6 in cashier's tray marked "Purchase Vouchers Unpaid" until date of check drawing. It is then sent by cashier to mailing clerk; he forwards it to payee, first detaching, at the perforated line, the right-hand portion containing account details which do not concern the receiver of the check.

correct, as receiving is less hazardous than disbursement. So far as clerical labor expenditure goes, it is difficult to find a detail where the slightest saving is possible.

No literary ability is required anywhere; there is no letter to be written; all that is needed is the careful filling of blanks in printed forms, and the correct transfer of items furnished, and correct addition by use, in the Cottrell offices, of the comptometer, of which there are two in the cashier's office.

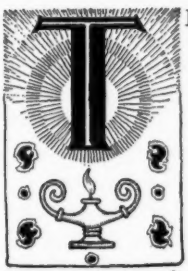
Not only is it difficult to see how the purchase and payment labor could be diminished, but it is not at all easy to see how disbursement could be more fully safe-guarded, and made more certainly impossible without concerted action by several different persons; because even granting a combination to defraud the factory by fictitious entries, no matter where made, discovery of the wrong would be certain and soon. The forms shown are especially adapted to the manufacture of the Cottrell printing presses, but, in substantially the same forms and with exactly the same uses and functions, this purchase and payment organization may be said to be the standard for thoroughly systematized practice.

FOUNDRY MANAGEMENT IN THE NEW CENTURY.

By Robert Buchanan.

VII. THE QUALITIES AND TRAINING OF THE FOUNDRY MANAGER.

With this article Mr. Buchanan closes a group of papers which, beginning in December last, have covered the field of foundry management. The topics, in the order of their presentation, have been:—the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant; crane service for the foundry floor; moulding by hand and machine; the specification and purchase of supplies; the management of the cupola; and the dressing of castings. This concluding review is particularly noteworthy for its sound statement of a policy toward the question of wages and work which must in the end prevail with both employers and employees.—The Editors.



HE foundry manager will often find himself called upon to advise as to the reason for certain matters having occurred by which castings are faulty or, perhaps, waste. He is fortunate if his men look up to him as being the most skilful man in the foundry, and hardly anything so gains the respect of men as superior skill. There is only one thing higher than skill, and that is character. The proof of good management is supplied by the machine-like regularity of production. This regularity of production should be accompanied by a gradual decrease of costs, though such decrease may be a declining ratio as the larger and more obvious wastages are eliminated. Where, as is sometimes possible, one can introduce methods by which costs are decreased and the earnings of the men increased, it is a very fortunate condition of matters. Decreasing costs by breaking prices, without compensation of another sort, such as improved methods or new tools, is usually evidence of poverty of resources.

The system under which payment is made for work done in the foundry is naturally of the greatest importance. Piece work, when fairly and justly applied (as with a few exceptions it may be said to be) has produced results superior to those of day work, both as regards low costs and the effect on the men themselves.

Efforts have been made, not quite successfully, to introduce the premium system of payment into the foundry. Employers who have seen it accepted by engineers are chagrined to find it rejected by the moulders. The latter are remarkably conservative in all that concerns

them, whether it be trade operations or conditions of employment. There is the ever-present fear that changes brought about by forces or agencies external to themselves cannot possibly be designed to benefit them. It may be admitted at once that the benefitting of workmen pecuniarily is not usually the first object when bringing about changes in modes of work or mode of payment. The first object in view is reduction of cost. Paradoxical as it may appear, it is only by reduction of costs that higher wages are made possible. The best friend to those who live by work, whether of brain or hands, or both, is the man who makes a business pay. Where the business is slackly conducted, discipline lax, and waste of time and material rampant, it is only a question of time when the workers have to go seeking work from those who know how to make it profitable. Seeing this is so, what is the objection to the premium system in foundries? Simply that the organisation of foundries generally is deficient. The workmen know it, and do not choose to take risks under such conditions.

The working conditions of a foundry are exceedingly complex, and if a premium system of payment is to have any chance of adoption and permanence, the particular operations to be done by the moulder must be clearly defined and adhered to by both the contracting parties.

The difficulty of drafting such a scheme is not insuperable, and the solution will necessarily be along the lines of having moulders simply doing moulders' work, it being a matter of agreement whether that includes such matters as the filling of sand into his own moulding box, emptying the castings, watering and mixing the sand, mixing facing sand, etc. The actual ramming and finishing and casting of the mould must be the work of the moulder. In some foundries the casting is done for the moulders, but unless under very special conditions, such a course is not advisable. No man is so competent to pour a mould as the man who made it. Mouding boxes (flasks) in proper working condition and as well suited to the pattern as the resources of the establishment can supply should be provided ready to his hand for the moulder's use. The well-equipped foundry would thus benefit from its outlay in providing suitable plant; the badly equipped would have to pay a higher moulding price if the plant be scanty or unsuitable.

There is little use of employers thinking that by a premium or any other system something is going to be got for nothing. What is possible—not only possible, but highly desirable—is the drawing out of the highest capabilities of the men by a knowledge on their part that brain power, experience, bodily strength, deftness of eye and hand,

shall meet with their due monetary reward. Any course of action which seeks to secure the extended exercise of the qualities mentioned without payment for the same, could result only in a speedy drift back to the position left. On the other hand, it is time that trade associations ceased bolstering up the inefficient or slow worker at the expense of the skilful and able. That the unions are of least benefit to the able workman is a truism, and is recognised as such by members of the unions. It follows that the lower grade of skilled labour benefits at the expense of the higher.

It is well to recognise that there is no power in heaven, or on earth, or under the earth can ultimately save the mediocre man from the penalties which attach to mediocrity. Attempts to carry him at a higher level of remuneration than his mediocrity deserves are like as if one carried a large stone all day, just to shew that the law of gravitation did not apply as regards that stone. Night comes, however, and the arms are weary and gravitation is as powerful as when the task was begun. It is as immoral to overpay as to underpay.

It is highly desirable that a basis of agreement shall speedily be found by which the best qualities of the men may be drawn out to the fullest extent and rewarded accordingly.

Before such an agreement can be made there must be a give-and-take by both parties. The unions must consent to greater and unretarded exercise, by the individual, of the high qualities which it is gladly admitted many workmen possess, with the inducement of permanently increased earnings set before him. Be good enough to note the word "permanently," as on that depends the success of any endeavour to draw out the best effects of the men. Unless there is permanence of reward there can be no permanence of effort, and it is foolishness to expect it to be otherwise.

We may be pretty well certain that were the men assured of this permanence of reward, there would be a very different response made than that which we have noted when efforts were made to draw them out.

One contributing cause by which good management may be obtained is a regular system of balancing or checking of the cost of the output at short periods. The ever-present consciousness that mistakes or bad management will inevitably be found out at the end of a month or quarter has a considerable retarding effect on erratic or badly judged changes. To some minds a far-away reckoning has only a slightly deterrent effect. Few minds, however, can look with equanimity for an early date when awkward explanations are necessary. Thus, short-

date balancings are of value in checking dubious courses, or extravagances in any direction, and so tend to good management. Responsibility of the individual for results is imperative. Where the operations form only a part of and are mixed up with those of other departments, it is impossible to have the same zest, initiative, and carefulness, which obtain where an individual is responsible for bad management or gets the credit for good. On the other hand, there is sometimes a tendency to reduce or contract the powers of the foundry manager without decreasing his responsibility. All are not in the favourable position of the performer, who, though swathed in ropes, can perform wonders, and yet it appears sometimes as if such a feat were expected to be not only possible to the foundry manager, but easy. Checks, rules, and regulations are a necessity, but when they descend to a system of "red-tapeism" they have become an evil. It is to be guarded against that instead of doing work people spend their time in talking or writing about it.

Training of Apprentices.—As the future of the trade of foundry works depend on the number and quality of the apprentices, their training requires more attention than it is presently receiving. The way in which the apprentice is too often exploited by being kept at one class of work because he does it well and cheaply, restricts the ultimate usefulness of the man to the industry and makes it well nigh impossible for such an one ever to get beyond the mere drudgery of the business. The trade unions endeavour to restrict the number of apprentices, and too many employers unwillingly aid and abet them in the same direction by following the course indicated. What can be the quality of workman turned out by a foundry having amongst its rules one which declares that any apprentice seen upon the cupola platform would be fined? The killing of the goose that laid the golden eggs was a sane proceeding compared with that which kills the legitimate and praiseworthy curiosity of the lad who wants to know all that it is possible to know about the business by which he is to live and make his way in the world, and by so doing prove a source of profit to those employing him.

We are now in a period of rules and regulations which say to the apprentice, thou shalt not do this; thou shalt not do that; and we enter his shortcomings in books and damn him, sans ceremony. It is time we began a constructive period for apprentices. The foundry manager who sets himself to the duty of properly training his apprentices builds for himself a lasting monument in the skill and character of the workman he turns out.

The Training of the Foundry Manager.—The foundry manager who is in demand, a rapidly decreasing demand, is one combining a thorough knowledge of foundry operations with at least a fair knowledge of science so far as it affects his work. In considering the training necessary to produce an efficient foundry manager it is well to remember that undoubtedly the present is a time of transitions. As in so many businesses the requirements daily increase, in number and intensity. The efficient foundry manager of today ought to equal the foundry manager of a quickly perishing period in knowledge of ordinary foundry processes, but in addition he must know something of the causations, physical and chemical, which underlie these processes. It is a debated point whether practical work or technical knowledge should be acquired first. I am of opinion that the best results are obtainable when a good knowledge of practical iron founding has first been obtained, and to that is added technical knowledge, bearing on the subject. Young men are more and more in request for the highest responsibilities, and concentration of work and study is the only way by which they may adequately fulfill the requirements. It would be foolish to claim that we know all the laws brought into play in the course of production. It is still more foolish to neglect to use those which are knowable. Some of us have had the privilege of working with, or have been under the influence of, foundrymen whom it was a privilege to know. It is hopeless to think of excelling some of these in the knowledge of practical work which they possessed. We are fortunate if we can equal them in this respect and at the same time graft upon practical knowledge a scientific insight, which was hid from them. To him who takes scientific work first, the practical work taught in technical colleges, however complete the curriculum and equipment of the college may be, can only be introductory to the more serious training of the foundry which exists by reason of its being able to meet any competition. There only may be learnt the great art of handling men effectively, and self-reliance acquired from successful control of work on a large scale. Young men who have first gone through university or technical college classes are very apt to think that with their superior theoretical knowledge they can go into a foundry, keep themselves apart from the workmen as something superior, and yet acquire a practical knowledge of the business. They never make a greater mistake. The workmen are the custodians of the accumulated practical experience of a century, and they impart their knowledge only to those who win their confidence.

The man with scientific training is wanted in the foundry, but only

if he can produce results superior to those of the man who is practical and nothing else.

That the foundryman of today needs all the aid which science can give him is not a sentimental opinion. The fact is not to be gainsaid that engineers are year by year adding to their demands for more excellent and reliable materials. Time was, and that not so very long ago, when specifications required test bars 2 inches by 1 inch supported at two points 36 inches apart to sustain without breaking a strain of 28 hundred weights, applied at the middle of the bar. Most iron founders thought they were doing very well when they met the requirements stated. Now when engineers are demanding that 30 hundred weights be applied at the middle of a similar bar, without fracture, what are iron founders going to do to meet the demand? To meet it successfully they themselves must either have a thorough knowledge of the mixing of metals or they must depend upon such knowledge in others. The latter position requires the purchase of irons already mixed suitable for the purpose, and this costs money. The one who knows how to mix metals such as will give the tests required, is in a very much more advantageous position as regards cost of production, and orders inevitably gravitate to those who produce cheaply, and not only promise, but fulfill, high tests.

Those who have studied most the problems which present themselves in foundry work are most aware that the solution of these problems is anything but obvious in most cases. Here there is room for the most powerful mind, the brightest intellect, for as yet we are looking only on the surface of things and much of value lies hidden below.

EDITORIAL COMMENT

THE scheme for the thousand-ton barge canal from the Lakes to the Hudson, just at its present stage, bears a strong resemblance to the Nicaragua Canal scheme at the time when THE ENGINEERING MAGAZINE first took up the fight for the best route for an Isthmian Canal. There is no more question that a waterway must be built from the Great Lakes to the sea than that the world's commerce must be given a quick and direct passage across the American isthmus. But it is far more clear that the particular project which the people of the State of New York are asked to adopt and pay for does not meet any of the requirements. It is almost the most expensive and least efficient that could be devised, and worst of all, has been so conceived deliberately in the protection or furtherance of certain selfish interests which short-sightedly think to fatten at the public expense. The object and intention has been to limit the use of the canal to vessels which cannot navigate the Lakes, and hence to secure to Buffalo the "profits" of the trans-shipment of every ton of cargo from Lake carriers to canal barges.

Engineering News, quoting from an able report by Mr. Wm. Pierson Judson, draws an instructive comparison between the proposed inland route and the possible route *via* the Niagara River and Lake Ontario. The latter could be opened many years earlier, and (with temporary use of the Welland Canal) at barely half the cost. In its entirety, it would save largely in maintenance cost and in time of transit for vessels, by the inclusion of 195 miles of open-water navigation. *Engineering News* well says that "every consideration of sound business principles and common sense would indicate that this route should be built upon" in preference to adopting the $101,000,000 scheme with which the politicians have hoped to stampede the people.

We should go further yet. It does not need a very distant vision to see the necessity for a channel from the Lakes to the sea large enough to give safe passage to full-sized cargo steamers. With the present-day rapidity of movement in commerce and industry, that necessity will almost certainly be pressingly felt long before the waterway can be opened. Any project which is adopted should have in ultimate view the extension to a regular ship canal. And on the inland route this is practically impossible.

* * *

THE whole industrial world seems to have been seized with the strike madness. On every side we hear of labor wars and rumors of labor wars, and there are those who take the gravest view of the situation. We are not so pessimistic, though it may well be admitted that in certain lines—the building trades, for instance—activity is not at all likely to be resumed on the same scale, and the check given by the labor agitators may very probably merge into a long depression of which the strikes will have been the precipitating, though not the only, cause.

But in the main, the very violence and general outbreaking of the trouble may serve to force a more serious attention than has heretofore been given

to its characteristics and its removal—or at least its reduction. The settlements effected are likely, we believe, to be dictated less by expediency and more by a just appreciation of the fundamental principles involved. Some few ruling decisions will be established which will go a long way toward lessening future contest. The public, the employer, and the employee will all get clearer views on certain points which they have heretofore seen "through a glass, darkly."

One of these—and to many it will appear the most salient—is with regard to violence. With discouraging slowness, no doubt, but (we believe) with certainty, there is crystallizing a public repudiation of the methods of brutality which have so often marked—and do yet so often mark—the efforts of strikers to carry their point. This repudiation is extending not only to the leaders who permit, but to the public officers who do not suppress, the disorder. There is a gradually growing perception that the striker who assaults a "strike breaker" is no more of a hero and no less a criminal than the grocer who dynamites his competitor's store—that union violence and intimidation are exactly on a plane with White Cap outrages, or Molly Maguirism, or the atrocities of the Ku Klux, or any other attempt to set up a non-legal system of rules of conduct and to enforce it by violent invasion of the life, liberty, and property rights of the individual who does not bow to the artificial code of the organization.

There is another point where labor will make a little progress toward wisdom—a very little, but some—and that is in the direction of understanding what things the legitimate power of organization can be exerted to secure. In resistance to oppression, in redressing of real grievances, in bettering the market for labor and in securing the highest market price for it, in association for mutual protection and improvement—in these and many other estimable objects, legitimately pursued, labor organizations have unquestionable right and ample scope to occupy themselves. But when they attempt to deny and prevent individual freedom in the purchase and sale of labor they will fail, because they are running counter to the immutable laws of justice; and when they attempt to fix a meagre limit to a man's productive effort and refuse him the right to pass these artificial bounds, they will fail, because they are running counter to the fundamental principles of economy and the laws of natural development. If such tactics could succeed, they would bring all society first to stagnation and then to rapid decline; but they will not succeed so long as Nature continues to implant the principle of growth in every living organism. It is hard to say which impression is uppermost—of the absurdity, the pitifulness, or the stupidity of the little labor councils, looking back over the progress of the past half-century and the men and policies that have made it, and then trying to regulate the future by cramping the spirit and genius of every worker within the confines set by the least ambitious or most slothful of them all.

As to the employer, the thing which has grown clearer is that the right of organization belongs to labor, and that exasperating and intolerable as many of its present manifestations are, it holds some of the most promising possibilities for a greater future stability. The unions cannot be "smashed." That effort is as hopeless as it is unjustifiable. They must be dealt with—not according to their own often distorted ideas, but with fair reason and common sense so far as these can prevail, and with firmness supported by the strength of employers' organizations where their education needs the rod.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

TECHNICAL EDUCATION IN AMERICA.

THE TRAINING OF ENGINEERS IN THE UNITED STATES AS VIEWED BY BRITISH AND AMERICAN ENGINEERS.

Prof. W. E. Dalby—Mr. J. A. L. Waddell.

LAST year Professor W. E. Dalby made a visit to the United States at the instance of Mr. A. F. Yarrow, to study the methods of technical training there in vogue, together with the relations of such training to the subsequent active participation of the students in engineering work. The result now appears in an interesting paper presented by Professor Dalby before the meeting of the Institution of Naval Architects, which evoked an instructive discussion. At the outset Professor Dalby stated that the general opinion in the United States is that an engineering training must include a college course, and the apprenticeship rules are generally framed in full recognition of this principle, the men passing without difficulty from the college to the works. He therefore examines the subject from both the standpoint of the technical educator and of the employers and works managers.

So far as the question of general technical education goes, the paper presents in a clearly tabulated form the nature and extent of the work done at certain typical American colleges, those selected being Harvard, Yale, Columbia, and the Massachusetts Institute of Technology. Professor Dalby states that these are among the highest institutions in the United States, although there are many more of practically equal standing from a technical point of view.

The principal features of interest brought out by this portion of the paper are the wide latitude permitted to the student in his selection of a course, coupled with a very definite amount of standard instruction. In general, a technical education in the United States really means four years of continuous hard work at a college fully equipped with engineering laboratories and workshops and with all the appliances and educational apparatus for giving a scientific education.

Taking the colleges named, the tuition fees range from £30 to £40 per year, while the actual cost of the student to the college is much more than the amount of the fees which he pays. Thus, at the Massachusetts Institute of Technology the average cost per student is £59, of which each student pays on an average only £35. In general, the fees paid by the student represent only about one-half of the total income of the institutions, the balance being made up from income on endowments, state and municipal grants, and gifts from private individuals.

The portion of Professor Dalby's paper, however, which is of the most immediate interest, is that which relates to the manner in which the students in the United States pass almost immediately into the workshops of the country and become at the same time producers and wage earners, completing their scientific education by practical hard work in the shop.

It is now generally recognized by employers in America that a man with a technical training makes a better apprentice and develops into a better officer than a man with only an ordinary education. As a result, nearly all the technical colleges find

that their graduates are in immediate demand, and it is not infrequently the case that the applications from employers for technically trained young men exceed the entire number of available members of the graduating class.

In most instances the young men enter the establishments under a regular system of apprenticeship, and Professor Dalby gives as typical examples of these systems those of the Pennsylvania Railroad Company and the Baldwin Locomotive Works. The principal point about these systems is that they recognize that the technically trained man is far more apt at learning shop methods than the less scientifically trained ordinary apprentice, a special classification being made for them, giving them ample opportunities to learn and to make themselves more and more useful and valuable. No premiums are paid to the firm by any of the apprentices, and substantial pay is given at once, rising according to a pre-arranged scale based on the period of service.

As Professor Dalby says:

"Generally speaking, the attitude of the American employer towards the college graduate is one of distinct encouragement, and of advantage to both. The employer gets the advantage of a trained intellect and the employee gets the advantage of his employer's shops and business experience. The American employer keeps an 'open door' for the technically trained man, whilst with us in England the door is too often closed by rules regarding age and the like, and the would-be apprentice not having sufficient means to pay a premium in addition to the amount he has already paid for his education. In cases where college graduates are taken on in England, they are, as a rule, expected to go through the same course as a boy entering straight from school. The Americans are more yielding in this respect, and do not insist upon the drudgery of the first few years.

"Whether the American system would succeed in England is an open question. The conditions in this country are somewhat different. I venture to think, however, that if employers would carefully consider the question in relation to the future of engineering in this country, there would result a greater co-operation between them and our technical colleges. The rules of apprenticeship would be altered so that the technically trained man would find an opening, and in this way employers would provide the opportunity, without which the best man has no way of showing his genius."

In the course of the discussion upon Professor Dalby's paper, Mr. Yarrow made some very pertinent remarks, especially calling attention to the fact that a mere technical education does not necessarily make a competent engineer. Success of men at college only indicates that they made good students, and it does not in the least degree prove that they have any aptitude for the engineering profession—that they are clever with their hands, that they have the power to control men, or that they have any inventive faculty. It does not follow that a scientific man will make an engineer, but in these days, to occupy an important post, an engineer must be a scientific man. Mr. Yarrow also presented a scheme to be adopted in the works of his firm at Poplar, for the admission of technically trained apprentices without premium, practically on similar lines to the systems in use in the United States.

In this connection it is interesting to glance at some features in American engineering education, as viewed by an eminent civil engineer. In an address to engineering students, Mr. J. A. L. Waddell threw some lights upon the value of a scientific training as it appears to the technically trained engineer after he has been in practice for many years, and has found out just what relation his education has borne to his work.

Thus the idea that it takes the brilliant student to become a good engineer is often erroneous. Many a slow-thinking student, who may have just succeeded in passing the examinations, has become a successful engineer, while it is well known that many of the finest mathematicians who graduate from the technical schools are never heard from afterwards in the engineering world.

So far as the question of premium is concerned, Mr. Waddell says that the young man should be content to work at first for little or nothing, and calls attention to the fact that in England premiums are required, but he mentions the fact that some engineers are getting rather tired of hav-

ing young men in the office as pupils who leave just about as they are beginning to make themselves really useful.

The active interest which is being manifested in the close connection between technical training and practical enginering development is most important, and there is little doubt that the future is the brightest for that nation which develops to the maximum the applied science of engineering as related to its manufacturing and technical industries.

RECENT DEVELOPMENTS IN RADIOACTIVITY.

THE SPONTANEOUS DISENGAGEMENT OF HEAT BY THE SALTS OF RADIUM—THEORIES AND EXPLANATIONS.

MM. Curie and Laborde—Comptes Rendus.

THERE has been much inaccurate talk of late concerning the properties of the radioactive elements isolated and studied especially in France by Mme. and M. Curie, M. Laborde, M. Debierne, and others, and hence the recent paper of MM. Curie and Laborde in the *Comptes Rendus* of the French Academy is to be welcomed as giving an authoritative account of the facts which have thus far been discovered.

There appears to be no doubt that the metal radium and its salts do emit heat in a continuous manner. In their experiments MM. Curie and Laborde arranged a thermo-electric couple, the junctions of which were enclosed in small bulbs, these in turn being carefully insulated from external heat. Into one of the bulbs was placed a gramme of radiferous barium chloride, containing about one-sixth of its weight of pure radium chloride, while in the other bulb was placed a gramme of pure barium chloride. A difference in temperature of 1.5° C. was observed between the two bulbs, the one containing the radiferous salt having the higher temperature. The result was checked by filling both bulbs with pure barium chloride, when practically no difference in temperature was observed.

The amount of heat emitted was determined quantitatively by causing the bulb containing the radium to impart its heat for a given time to a block of metal. A similar elevation in temperature was subsequently produced in the same block by means of an electric current of known intensity heating a wire of known resistance, and the energy disengaged was found to be about 14 gramme-calories per hour. Owing to some uncertainty as to the precise amount of radium in the salt with which the experiments were made, it is not certain just how much heat would be emitted by pure radium, but it may be closely approximated to about 100 gramme-calories per hour emitted by one gramme of radium.

It is impossible to explain the disengagement of this quantity of heat upon the hypothesis of any ordinary chemical transformation. If it is due to any internal transformation of the substance this transformation must be of a more profound nature, and may be due to a modification of the radium atom itself. If so, it takes place with extreme slowness. The properties of radium do not appear to undergo any appreciable change under a close examination, lasting over several years. Spectroscopic examinations made by Demarçay with an interval of five months upon the same specimen of radium chloride showed no appreciable variation. For these reasons the explanation of this disengagement of heat is being sought in other directions, and it is thought possible that some external energy of an unknown nature is thus transformed.

In discussing this subject in a recent communication to *The Times,* Sir William Crookes shows that there is a large amount of energy locked up in the molecular motions of quiescent air at ordinary pressure and temperature, and refers to the fact that as long ago as 1898 he suggested that radioactive bodies might draw upon this store of energy. The atomic structure of radiant bodies may be such as to enable them to throw off the slow-moving molecules of air with little exchange of energy, while the quick-moving missiles are arrested, with their energy reduced and that of the target correspondingly increased. The energy thus gained by the radioactive body would raise its temperature, while the surrounding air would become cooler.

Although the fact of emission of heat by radium is in itself sufficiently remarkable, this heat is probably only a small portion of the energy radium is constantly sending into space. It is at the same time hurling off material particles which reveal their impact on a screen by luminous scintillations. Stop these by a glass or mica screen and torrents of Röntgen rays still pour out from a few milligrammes of radium salt, in quantity to exhibit to a company all the phenomena of Röntgen rays, and with energy enough to produce a nasty blister on the flesh, if kept near it for an hour.

In a paper recently presented before the Royal Society, and published in the *Electrician*, Sir William Crookes discusses in general the emanations from radium, and emphasizes especially the peculiar manner in which they cohere to almost everything with which they come in contact. Thus filters, beakers, and dishes used in the laboratory for operations with radium, after having been washed in the usual way, remain radioactive, a piece of blende screen held inside the beaker or other vessel immediately glowing with the presence of radium.

Sir William Crookes describes a number of experiments made with the crystalline residue obtained by evaporating to dryness a solution of radium nitrate. The crystals themselves were but feebly luminous, but a number of interesting effects were obtained by the use of a screen of Sidot's hexagonal blende (zinc sulphide), this becoming phosphorescent when approached to the radium, the effect lasting from a few minutes to half an hour or more, according to the strength of the initial excitement. When a piece of solid radium nitrate was brought near the screen a general phosphorescence was produced, together with brilliant scintillating spots, these spots not being confined to any one position, but appearing rapidly at different points without any apparent movement of translation. A number of curious effects in connection with these scintillations are described, but after all the main feature of interest in all the emanations from radium and its salts lies in the question of origin. Up to the present time no satisfactory explanation has been given for this apparent creation of energy, and yet it is impossible to assume that the heat and light effects, and the Röntgen rays, are produced in contradiction to the laws of the correlation of force and the conservation of energy.

The hypothesis of Professor Crookes, noticed above, that the radium simply acts as a medium for dissociating energy from the atmosphere may be correct, and in answer to a query as to the fact that this view would involve the suspension of action in a vacuum, the reply is made that what is ordinarily called a vacuum is very far from being such in the sense in which these actions are understood.

The highest vacuum which it would be possible to produce would still contain ample matter to comply with the hypothesis of Sir William Crookes, and in default of a better explanation of the action of radium it is probable that his views will at least form a guide for further experimental investigations.

THE NATIONAL PHYSICAL LABORATORY.

AN ADDRESS BY DR. GLAZEBROOK UPON ITS RELATIONS TO ENGINEERING AND THE SOLUTION OF PRACTICAL PROBLEMS.

Institution of Mechanical Engineers.

IN an interesting lecture recently delivered before the graduates of the Institution of Mechanical Engineers, the Director of the National Physical Laboratory, Dr. R. T. Glazebrook, F. R. S., gave an account of the relations of that institution to engineering, with some excellent examples of work already accomplished in that direction.

After a detailed description of the mechanical equipment of the engineering laboratory at Bushey House, new buildings having been constructed for this department. Dr. Glazebrook proceeded to discuss some examples of the work performed, and in so doing he called attention to the fact that the operations might be classified under three heads; namely, rou-

tine test work; original investigations undertaken at the request of the engineering committee; and, inquiries and experiments made at the request of engineers and others, and for which fees are received.

Routine test work includes the comparing of standards of length, for which proper comparators are provided; also for the calibration and reproduction of standard screws. An especially well equipped department is that for testing and standardising pressure gauges. A mercury column 50 feet high, provided with a scale graduated into millimetres, pounds per square inch, kilogrammes per square millimetre, and feet of water, has been constructed, a lift enabling the entire length of the column to be readily accessible. This enables pressures up to 300 pounds per square inch to be read directly, while by use of a differential direct-weight testing apparatus pressures up to 8 tons per square inch may be used. The thermometric laboratory is prepared to make accurate comparisons directly with the nitrogen thermometer up to about 900° C., while instruments reading up to 1,300° C. can be accurately standardised by comparison with platinum-rhodium thermo couples.

The laboratory is well equipped for studies in metallography, and sections of rails, girders, and other metallic members can be examined and microphotographs made for record and comparison. At the present time the laboratory is not provided with such a testing machine as should be in such a place. Doubtless much of the testing of materials of construction will always be made at the works of manufacturers, but there should be a means of ultimate reference to an official testing machine of undoubted accuracy, in the hands of disinterested observers, so that disagreements might be cleared up and authoritative records made. In the United States the great Emery testing machine at the Watertown Arsenal has admirably filled this position, and the valuable series of volumes issued by the Ordnance Bureau bears witness to the extent to which it has been used.

In this connection Dr. Glazebrook calls attention to an interesting point which may well be expressed in his own words. Says he:

"Englishmen are conservative; the high-class maker does not want the tests—he knows his products are good; his cheap and nasty rival does not want the tests—they will expose his weaknesses.

"One firm of deservedly high reputation wrote to me a short time back, saying: 'It would never do for us to admit that our goods stood in need of a certificate.'

"Forgive me if I state plainly my opinion that in many cases at any rate the high-class maker is wrong. A certificate such as we can give can only help him and expose his inferiors."

In the line of research work much that is of interest is in progress. Thus the work of the alloys research committee of the Institution of Mechanical Engineers is to be continued at the laboratory, and already much valuable study has been given to the properties of nickel steel and of nickel-manganese steel. These include experiments on the elastic fatigue of metals, a machine now being under construction by means of which stresses of known amount and frequencies up to 1,200 to 1,500 per minute may be applied to a test specimen.

Another most important line of research work is that of wind pressures on engineering structures. These experiments are the outcome of those made by Sir Benjamin Baker at the time of the building of the Forth bridge in 1884, supplemented by the anemometer experiments of Mr. R. H. Curtis at Bidston and Holyhead in 1900. These investigations all consisted in the observation of natural wind pressures, and hence there was no way of checking the accuracy of the work. At the laboratory the wind forces are artificially produced, and hence under definite control, and the pressures and their effects may be accurately and precisely determined. Although the entire apparatus is on a greatly reduced scale from anything in practical work, the wind pressures on actual structures can be calculated with the same kind of accuracy as is obtained from the computation of the actual resistance of a ship from an experiment in a tank.

In regard to the third department of the work of the laboratory, that of making special researches for engineers and others, for which fees are received, this must naturally be a matter of growth as its importance and value are appreciated. Such tests are obviously confidential, and the results are the property of those for whom they are

made. At the same time some instances are given in which the results were permitted to be made public, and one of these, a series of tests on a tool steel, is given in detail by Dr. Glazebrook. These included tensile tests, tests of hardness, cutting tests, chemical analyses, and photomicrographic examinations of the structure. The results showed the suitability of the steel for use in making cutting tools, and gave definite information as to the methods to be employed in its use. Before the establishment of the laboratory there was no place in the country where such an investigation could have been conducted on the application of a private individual, while at Bushey all the work, except the original forging of the ingot, was performed on the spot.

Another example of the value of the work done at the laboratory is found in the determination of the specific heat of iron at high temperature. In the measurement of the temperature of a furnace by the use of a mass of iron and a calorimeter it is necessary to know the specific heat of iron, and although this has been known to vary with different temperatures, it had, until recently, not been definitely determined. At the request of a correspondent of the laboratory the subject was investigated, and, according to a new series of experiments made by Dr. Harker, the specific heat of iron has now been accurately determined and plotted on a diagram for temperatures from 300° to 900° C.

The progress of such an institution as the National Physical Laboratory must necessarily be slow at first, but the development of the Reichsanstalt at Berlin has shown what may be accomplished, and when, as has been indicated by Dr. Glazebrook, the immediate value of the laboratory to the engineering profession is appreciated, it will doubtless become an important factor in the development of applied science in Great Britain.

HOLLOW PRESSED AXLES.

THE IMPROVED METHOD OF FORMING RAILWAY AXLES BY PRESSURE AT THE HOMESTEAD STEEL WORKS, PITTSBURG.

Camille Mercader—Iron and Steel Institute.

UP to the present time axles for railway service have been forged under the hammer, and the greatest care has been found necessary to secure a product which will stand the severe drop tests demanded by the specifications. Larger shafts have been produced under the forging press, and by operating with an annular blank the pressure can be exerted upon the interior as well as the exterior, and much better results obtained than by forging solid masses under the hammer. In the case of railway axles the advantages of the hollow form have been appreciated, since in many cases the completed forgings have been bored through from end to end to remove the defects due to segregation and piping of the ingot. In order to secure a higher grade of product, as well as to increase the rate of production, an improved method of manufacture by pressure has been devised by Mr. Camille Mercader, and a description of the process, as carried out at the Homestead Steel Works of the Carnegie Steel Company at Pittsburg, formed the subject of a paper presented by him before the Iron and Steel Institute.

Mr. Mercader's process is almost audacious in its simplicity, and depends almost wholly for its success upon the power and perfection of the machinery by which it is carried out, and a large portion of the paper is devoted to a description of the press and other machinery designed for the work and in use at Homestead.

"A rolled round steel blank, uniformly heated, is inserted into a two-part die, having a matrix cavity in the form of a rough turned axle. The diameter of the journals is made equal to the smallest diameter of the axle in the center, which corresponds to the diameter of the round blank. After the dies are clamped about the heated round the latter is axially perforated simultaneously at both ends by two cylindrical punches, which force the metal of the blank to conform to the shape of the matrix die and fill out the same. The round is heated up to about 1,000° C. and the total hydraulic pressure required for penetration with

a punch of 3 inches diameter amounts to about 50 tons. During the last end of the stroke a total hydraulic pressure of about 150 tons is required because the blank loses its initial heat through contact with the dies and because the end collars upset, at which time the metal may flow back against the punch.

"Considering the small diameter to be pierced and the length of the punch, this pressure required to penetrate the blank is, apparently, very small, and it will be conceded by all familiar with the work that a prerequisite to entering the blank lies in allowing the metal to flow freely in the direction of the forward movement of the punch. The presence of the annular spaces between the blank and the die fulfills this condition, the metal flowing radially in the direction of the least resistance; the only back flow against the punch is at the end of the stroke."

In order to enable the metal to flow under the action of the pressure it is necessary that the blank shall be heated to the proper temperature, since the resistance would otherwise become too great. Experiments at Homestead showed that the lower limit is about 850° C., while at 1,050° C. the operation can readily be performed, a pressure of about 150 tons being found sufficient.

In the course of the extensive experiments which have been conducted in the development of the process, a number of interesting facts have been developed. It is most essential that the blank shall be straight when it is placed in the press, since any deviation from the truth causes the punches to bend. The blanks are therefore passed through a straightening machine after leaving the furnace and before entering the press, this machine consisting of a pair of cross rolls arranged to give the blank a rotating, as well as a longitudinal traversing motion, the operation also removing all scale and delivering the blanks to the press not only straight, but also clean and smooth.

Numerous experiments were also made before suitable material for the punches was found. At first water-cooled steel punches were employed, but without great success. Crucible steel punches were tried, but it was found that the point of the punch became welded to the interior of the axle, and when withdrawn it was covered with steel, and was too rough to be used a second time. Finally success was obtained by using punches of high-carbon Bessemer steel, tipped with loose caps of drop-forged steel. The cap being slightly larger in external diameter than the punch, serves to protect it in entering, and since the cap is welded to the bottom of the hole in the blank each time the punch is readily withdrawn. The dies have thus far been made of cast iron, water cooled to prevent change in shape, and good results have been secured, although it is possible that cast steel dies may ultimately be employed.

With the experimental plant erected in Homestead, the time required to make one axle, all operations included, does not exceed two minutes. Allowing, again, two minutes for cleaning and black leading the dies and for cooling and capping the punches, the capacity of one press is 15 axles per hour, or 300 axles, 5½ x 10-inch journal, per 20 hours, which is fully three times the quantity accomplished with one hammer by the best American practice. The number of men required to operate the press remains the same as needed at the hammer to forge five 5½ x 10-inch journal axles per hour.

The advantages of the new method of producing axles by pressure as compared with the old process of forging are numerous. The present axle is of perfect form, necessarily conforming exactly to the interior of the die, and the shape can be best adapted to resist the stresses to which it is subjected with the least amount of metal, and any modification in shape which experience may indicate may be produced by making the proper dies. Since the forging action is carried out throughout the mass of the metal, both internally and externally, the material is found to be far more homogeneous than is the case with solid forged axles, the effects of segregation being entirely destroyed. The axle being as straight as the die in which it is made, no subsequent straightening is required, and the smoothness of the exterior renders it necessary to finish only the journals and the wheel seats, the finishing cost being thus materially reduced. So far as operative cost is concerned, fully three times as many axles can be produced with the same labor cost, while

the capacity of existing plants may be proportionally increased by the substitution of the new method for the old.

The weight of a 100,000 pound capacity steel car is decreased by 1.7 per cent., permitting this load, which amounts to 24,000 pounds in a train of 40 steel cars, to be used for other purposes, or a corresponding saving in energy to be made.

Mr. Mercader gives in his paper details of tests of the pressed axles, showing conclusively the high quality of the product, while the density and uniformity of the material is well shown by photo-micrographs of etched sections.

The development of this improved process for making railway axles is an excellent example of the transformation which is being made in modern manufacturing processes. By the use of apparatus of tremendous power and strength, a greatly improved article is made with a reduction of the labor cost to one-third, and the attainment of a higher operative efficiency for the plant.

MECHANICAL RECORDING DEVICES.

METHODS AND APPARATUS FOR THE PRACTICAL INVESTIGATION OF RAPIDLY VARYING PERIODICAL PHENOMENA.

Société des Ingénieurs Civils de France.

MANY of the modern problems of practical engineering involve the use of instruments and methods almost as refined as those formerly found only in the reseaches of the physical laboratory, and the engineer of to-day employs apparatus of much ingenuity and precision.

In a paper published in a recent issue of the *Mémoires de la Société des Ingenieurs Civils de France,* M. E. Hospitalier discusses the modern methods and devices for observing and recording occurrences and phenomena in engineering work, with especial reference to rapid and periodical variations, and some abstract of his article is here given.

In the domain of electrical engineering especially, it has become necessary to deal with rapidly varying phenomena of which the frequency attains a hundred, a thousand, or even ten thousand periods per second, and these facts have resulted in the development of practical industrial methods of investigation of great precision and convenience. Some of these methods are examined in the paper of M. Hospitalier, with details and illustrations of the apparatus.

A rapidly varying phenomenon may be studied by two different methods, using apparatus employing either direct or indirect observation. A direct apparatus must permit the observation or recording of the occurrences instantaneously, without producing any perturbations. Such devices for direct observation are of two kinds. The first involves the use of an apparatus having a very small moment of inertia and a very short period of oscillation compared with that of the phenomenon to be investigated, together with suitable damping devices. The second, especially adapted to the study of variable currents, includes thus far but a single device, the rheograph of M. Abraham, and is practically the opposite of the first method, involving a high moment of inertia and a much longer period of oscillation than that to be examined.

Indirect methods of observation may be considered as based upon the principle of the stroboscope, the periodical phenomena being practically delayed and a greater number of phases collected, many periods being observed together. This is accomplished by having the period of oscillation of the apparatus itself very great with regard to that of the phenomenon observed, while at the same time the duration of the whole of the periods thus gathered is relatively very great. The arcoscope, the ondograph, and the pressiograph are based on this principle.

Among the direct instruments, M. Hospitalier describes at length the oscillograph, this consisting of a very small band of soft iron, so mounted as to be capable of torsional vibration, and bearing a minute mirror of silvered mica, by means of which its movements may be magnified so as to become visible or recordable by photography. A series of uniform vibrations of any desired periodicity for purposes of comparison is also produced mechanically, usually

by means of a toothed wheel driven by a synchronous motor. The soft metal band acts in the same manner as a collection of minute magnets placed at right angles to its axis of torsion, and under the influence of varying electrical forces it responds promptly and proportionally.

The manograph of Hospitalier and Carpentier is another example of a direct instrument, and one of especial interest to the engineer, since it corresponds in its action to the indicator, so modified that it is capable of application to engines of such high speed as the small internal-combustion motors of automobile vehicles, when exposed to the shocks of actual service.

This device consists of a minute mirror mounted on three points placed at the corners of a right-angled triangle, with spring supports, thus being capable of movements about two axes at right angles to each other. The pressure in the cylinder is conveyed to the mirror through a flexible diaphragm in such a manner as to cause it to oscillate about the horizontal axis, while the movement of the motor shaft is conveyed by means of a flexible shaft and gearing to a minute crank shaft, causing the mirror to oscillate about a vertical axis in synchronism with the piston of the motor. A beam of light thrown upon the mirror will then be reflected from it with the resultant of both motions, projecting the indicator diagram upon a screen for visual demonstration, or upon a sensitive plate for photographic record.

M. Hospitalier gives examples of diagrams taken from a De Dion-Bouton motor, taken at 2,200 revolutions per minute, showing most clearly the effects of premature and delayed ignition, and having a far smoother and more satisfactory outline than those taken with the ordinary indicator from slow-moving steam engines.

The indirect, or stroboscopic, method is also discussed by M. Hospitalier, and its advantages shown for many cases. The general principle of the stroboscopic methods may well be shown by considering the example of simple uniform rotation. Suppose a rapidly revolving wheel in a dark room. If a flash of light is thrown upon it it will be seen for an instant. If successive flashes are made at intervals exactly corresponding to each revolution, the wheel will always be seen in the same position, and will appear to be standing still. If the flashes occur at slightly closer intervals than the rotations of the wheel, the latter will appear to be moving slowly backward, while if the flashes are slower than the revolutions the wheel will seem to be moving forward. The actual speed of rotation of the wheel may thus be visually retarded in a proportion depending entirely upon the rate of the successive illuminations. The same is true of any moving object, however irregular its motions, since it may be caused apparently to stand still or to perform its motions at any rate of speed determined by the frequency of the intervals of illumination. The lighting may be most conveniently effected by permitting the rays from any source to pass through slits in a revolving disc, since this enables the frequency to be controlled at will, giving opportunity to observe all the movements of the object under investigation, or to cause it to stand still in any desired position or period.

The wide scope of this method will at once be appreciated, and M. Hospitalier enumerates but a few of the devices which have been made involving its use. Thus by means of the arcoscope the variations in illumination of an arc produced by an alternating surrent may be observed, however high the frequency. By use of the ondograph the form and sequence of the waves of alternating electrical currents may be recorded and studied; while with the pressiograph the variations in pressure of high-speed thermal motors may be examined. These and other applications are discussed in M. Hospitalier's paper, and the ingenuity in the details of these devices, due to the efforts of many physicists of note, will afford many suggestions for the design of other special devices upon similar principles.

There is little doubt that the extending use of such methods and apparatus will do much to broaden the scope of engineering work and to increase the appreciation of exact quantitative processes in actual practice. The vast improvement in the steam engine which has followed the popularization of the indicator is an instance of the benefits which result from the use of accurate scientific methods in engineering work, and similar consequences should follow the employment of these later appliances.

SUPERHEATED STEAM FOR TURBINES.

A STUDY OF THE ADVANTAGES AND DISADVANTAGES OF SUPERHEATED STEAM IN TURBINES OF THE DE LAVAL TYPE.

E. Lewicki—Verein Deutscher Ingenieure.

FOR a long time the theoretical advantages of superheated steam have been fully realized, and it has been only the practical difficulties connected with its use in engines of the piston and cylinder type which have prevented its general use. Fully fifty years ago a number of important vessels were fitted with superheaters, among them the Great Eastern, but at the present time no vessel of importance is so provided, notwithstanding all the efforts which are being made to insure high steam economy. The principal difficulty experienced with the use of superheated steam lies in the action of the rubbing surfaces, including the effect of the high temperature upon the lubricant, and hence, when the seam turbine was introduced, it was realized that a machine in which there was no rubbing contact should be well adapted for use with steam at a temperature which would be impracticable in existing engines. At the same time it was understood that the greatest advantage to be expected from the use of superheated steam lay, not in the moderate increase in expansive force due to the higher temperature, but rather in the reduction in cylinder condensation. Since the conditions which conduce to cylinder condensation, such as the admission of live steam into a space from which cooler exhaust steam has just been discharged, do not exist in the case of the steam turbine, it has been a question as to whether any marked increase in economy was to be expected by superheating the steam, and the matter has therefore been left to experiment for determination. A series of important trials upon a turbine of the De Laval type has recently been conducted in the mechanical laboratory of the technical high school at Dresden, and the results are embodied in a contribution to the *Zeitschrift des Vereines Deutscher Ingenieure* by Herr Ernst Lewicki, from which we make some abstract.

The tests have been made during the past two years, upon a 30 horse-power De Laval turbine in the laboratory at Dresden, where facilities were available for experimenting with steam of 500° C. superheat, using a Schmidt superheater, as well as appliances for measuring power, temperatures, and water. Steam was supplied from a Schmidt boiler, and the consumption was accurately determined by condensing all the steam which passed through the turbine. Heat losses were provided against as fully as practicable by jacketing the apparatus, and the gauges and other instruments were compared and calibrated especially for the trials.

The turbine, built by the Humboldt Works, at Kalk, near Cologne, was arranged to be run at a speed of 20,000 revolutions per minute, reduced by gearing to 2,000 revolutions of the shaft upon which the brake was placed; and the machine was operated by steam of a pressure of 6 kilogrammes per square centimetre (about 85 pounds per square inch), and when exhausting against the pressure of the atmosphere it was rated to develop 30 horse power.

The measurement of the temperature of superheating, most important in this connection, was made by the use of a Le Chatelier pyrometer, immersed in an oil bath placed in the steam pipe close to the entrance of the steam into the turbine nozzles, and the calibration showed that the probable error in the temperature determination did not exceed 2½ per cent., the readings being taken for every 5° C. The revolutions were taken by a system of gearing forming a positive counter, and a tachometer was also attached to the second shaft, the speed determinations having a probable error of only 0.25 per cent.

An interesting feature of the tests is found in the use of nozzles of different materials and forms, experiments having been made both with diverging and with converging nozzles, using bronze and steel as materials. The precise dimensions of the nozzles are tabulated in the report, as well as other valuable data relating to the machine.

In conducting the investigations a certain number of definite questions were proposed

and the answers sought by actual trial, and the results are conveniently presented in that form in the original paper. Broadly the results of the trials demonstrate that a marked economy in steam consumption is attained.

Thus, when operating with steam at 85 pounds pressure, the steam consumption with saturated steam, when developing 21.4 horse-power was 21.6 kilogrammes per horse-power hour, or about 47 pounds. With steam superheated to 460° C., the power increased to 24.5 horse-power, and the consumption per brake horse-power per hour fell to 14.1 kilogrammes, or 31.8 pounds. At full load the gain was equally marked; the steam consumption with saturated steam, with a development of 44.1 horse-power, being 17.7 kilogrammes, and with steam superheated to 500° C. falling to 11.5 kilogrammes, or 38.8 pounds and 23.5 pounds respectively, per brake horse-power hour.

The experiments with various nozzles showed that the diverging nozzle, as proportioned by the designers of the De Laval turbine, gives better results than the converging nozzle, and is evidently based upon correct theoretical principles. For superheated steam, however, it was found advantageous to substitute steel for bronze for the nozzles.

An interesting feature of the tests was the determination of the frictional resistance to the movement of the wheel opposed by saturated steam and steam of various degrees of superheat. This was measured by driving the turbine wheel by an electric motor and measuring the power required to keep it in motion when the case was filled with the respective fluids. Thus, to maintain the wheel at 20,000 revolutions in air it required 4.6 horse-power, while in saturated steam at atmospheric pressure but 3.3 horse-power were needed. At 184° C. superheat the power to drive the wheel fell to 2.25 horse-power, while in steam superheated 300° C., only 1.88 horse-power were required.

One source of loss in connection with the use of superheated steam was the high temperature of the exhaust steam, the exhaust when the incoming steam was at 500° C. leaving at a temperature of 343° C. A method for utilizing this loss in a practical manner is suggested by Herr Lewicki, this being in principle a form of regenerator. If the hot exhaust steam is led off so as to surround the incoming live steam after it has left the boiler and before it enters the superheater, much of the heat will be made available for the preliminary portion of the superheating, the actual loss thus being made very small.

The entire report is the most complete mass of information concerning the use of superheated steam with the turbine which has yet been made public, and the accuracy with which the work was done and the precision with which the results are recorded render this a valuable contribution to modern steam engineering.

CONSULTING ENGINEERS AND THEIR WORK.

INAUGURAL ADDRESS TO THE STUDENTS OF THE CITY AND GUILDS CENTRAL TECHNICAL COLLEGE.

Dr. A. B. W. Kennedy—Engineering.

IN the inaugural address recently delivered by Dr. Alexander B. W. Kennedy at the Central Technical College, and published in *Engineering*, some very excellent advice is given, primarily to the students to whom the address was directly delivered, and also generally to members of the profession and others who will gladly profit by Dr. Kennedy's experience and judgment.

Dr. Kennedy first called attention to the two broad divisions in the profession, which may be called manufacturing engineering and consulting engineering, and confined his discussion mainly to the work of the latter class. In so doing he showed that there was no occasion to make any comparison between the two classes, both, in his opinion, being absolutely essential and both equally dignified. In fact, it is almost necessary for a consulting engineer to have had practical experience in the works of manufacturers in order that he may know the difficulties which are to be encountered in the execu-

tion of works subsequently designed by himself. With consulting engineers may also be grouped the great army of borough engineers, of engineers to municipal works of every kind, and of engineers to companies or firms who are not manufacturers.

The main duty of a consulting engineer is the formulation of what may be called "schemes." A corporation wants a water supply, or a gas works, or a company wants a big manufactory, a railway, or a bridge, or a design may be required for a tramway or other power house, or for an electrical transmission scheme. The engineer in such a case has not himself to design machinery, nor generally to design the details of anything, although he may have to design a general scheme of very great complication. Here, however, comes in a department of work which is not generally thought of in connection with engineering; that is, the financial side of the question. The consulting engineer must not only be able to estimate the cost of the work which he has laid out, but he must decide between the relative value of several schemes, and consider their financial relation to the undertaking of which they form only a part.

"The question as to whether a thing will pay is influenced by a great many conditions. It is influenced first by the immediate cost, which is not a very serious matter to arrive at by estimating. A much more difficult question is to arrive at the conclusion whether certain variations, certain improvements, or certain alterations, which will cost money, will yield a profit if carried out."

It is in this department of the work of the engineer that his best and most careful judgment must be exercised. As an engineer, he may readily be able to decide which of two methods is the better one, but the question is not always one of mechanical performance, but one of ultimate monetary advantage.

Thus it is well known that a condensing engine uses less fuel than one in which the exhaust steam is allowed to blow off into the atmosphere, and it is also settled that there is a decided economy in the use of superheated steam. At the same time the use of condensing engines is involved in the access to an abundant supply of water, or in the additional cost of cooling towers and accessories, and these vary in different localities. The gain by superheating may be far overcome by the cost of the apparatus and its attendance, and in nearly every instance there are local considerations which should be taken into account. As a well-known engineer in the United States once tersely put it, it is the economy of money and not the economy of steam, which the owner desires to secure. These are only illustrations of the fact that the consulting engineer must be at the same time an engineer and an economist in the broad meaning of the term, if he is to make a success of his profession.

Dr. Kennedy discusses the question of specifications in a very broad and liberal spirit. Too much detail should be avoided, as tending to take responsibility out of the manufacturer's hands, and cause needless expense to the client. At the same time the work to be done should be so clearly indicated that the various contractors may fully understand what is required of them. Anything unusual and original should be so fully described that there may be no difficulty about knowing how it is to be carried out, and no uncertainty exhibited as to the engineer's idea and meaning. If the work of certain contractors is especially desired it should be so stated, and others not put to the trouble of preparing tenders which are certain not to be accepted. The engineer, however, must not let himself be persuaded by a manufacturer that a thing cannot be done, when he himself believes that it can be accomplished. A manufacturer's evidence that a thing can be done is often final, at least if he has already done it; a manufacturer's evidence that a thing cannot be done is purely negative evidence; it merely means that he does not know how to do it.

The important subject of supervision and inspection naturally comes in for a share of the discussion. Here much difficulty may be avoided by having had a clear and definite specification. In all cases, however, questions will arise in which the engineer must hold the position of arbitrator between his clients and the manufacturers. He has first to see that his employers get what he has specified, while, on the other hand, he should see that the contractors are fairly dealt with. Questions of delays from unforeseen and unavoidable causes may oc-

cur, entitling the contractors to consideration, while, on the other hand, there will be occasions when absolute compliance with the conditions of the specification must be enforced. The position of the engineer should always be that of absolute justice to both sides, notwithstanding the fact that one side is his own client.

From the very nature of his occupation the consulting engineer is in a position to acquire a large and varied experience which places him in a position to know more about methods and machines than some of the manufacturers themselves. Each manufacturer knows all about his own work, but not so much about the work of other makers, and hence the consulting engineer, while always open to receive information, is usually in a position to state positively why and how a thing should be done. There are always many ways in which a thing can be done, and it is never wise to try to make a manufacturer alter details of his own merely to satisfy a personal fad. Far better to take advantage of all the knowledge and experience of the contractors who are carrying out the work, and be ready to add to this all the additional experience which has already been acquired.

Professor Kennedy adds some wise words as to the ethics of the profession, which, while they are at bottom only the precepts of common honesty, sometimes need just such a clear statement as he gives them, and thus he concludes an address filled with the wisdom of a ripe experience.

THE "KAISER WILHELM II."

THE LATEST ADDITION TO THE TRANSATLANTIC FLEET—THE LONGEST AND MOST HEAVILY POWERED SHIP IN THE WORLD.

Scientific American—The Nautical Gazette.

IN a review of modern transatlantic steamships, which appeared in these columns at the time of the launch of the "Kaiser Wilhelm II.," a brief account of her was given, and she was compared with some of the other great liners, but the completion of her first trip across the ocean furnishes an occasion for a more detailed description.

In her general appearance she is similar to her predecessors in the North German Lloyd, the "Kaiser Wilhelm der Grosse" and the "Kronprinz Wilhelm," and to the "Deutschland" of the Hamburg line, all of which were built at the Vulcan yard, in Stettin. She has the four buff funnels of the other big German liners, but carries three masts instead of two. When seen alone, her great length is not so striking, as her upper works are very high, and her lines are symmetrical and graceful. Her size is best realized when on board of her, particularly when one gets into a position where there is a clear view up and down the decks.

According to figures given in the *Scientific American* and *The Nautical Gazette*, the dimensions of the "Kaiser Wilhelm II." are: Length, 706 feet, 6 inches; beam, 72 feet; molded depth, 52 feet, 6 inches; load draft, 29 feet; and displacement, about 26,000 tons. The double bottom, which extends the full length of the ship, is divided into twenty-six compartments, while the hull itself is divided into nineteen watertight compartments. There are seven decks, known respectively as the orlop, lower, main, upper, lower promenade deck, upper promenade deck, and awning or boat deck. The vessel thus carries one more deck than is common in large passenger ships of her type, her predecessors having only one instead of two promenade decks; and by the way, these two decks are truly magnificent in their clear, unobstructed sweep from the bridge to within a short distance of the taffrail. To those passengers who spend most of their time on deck, the doubling of the promenade deck accommodation will be a great convenience. The passenger accommodation includes 290 first-class cabins and 107 second-class, and one of the show features of the ship is her two "imperial" suites, each of which includes a dining-room, drawing-room, bedroom, and bathroom, all most daintily and tastefully decorated. There are also eight suites that include sitting-room, bedroom and bathroom, and also eight state cabins with bathroom adjoining. The most spa-

cious room in the ship is the first-class saloon, a magnificent room, 69 feet broad and 108 feet long, which provides sitting accommodations for 554 passengers. The second-class saloon accommodates 190 passengers. The four kitchens, the largest of which is about 55 feet by 30, can cater to about 800 first-class passengers, 400 second-class, and 1,100 third-class, besides the crew, which numbers about 600 individuals, the engine- and boiler-room complement alone being 237. The actual number of passengers to be carried, however, will be limited to the seating capacity of the saloons.

There are many different apartments for the general use of the first-cabin passengers, all fitted up, in tasteful and luxurious style, with every convenience. Among these rooms may be mentioned a typewriting room, adjoining the library and reading-room, a safe deposit room, where passengers can secure private safes for storing their valuables, a children's room, gaily decorated with paintings representing the principal characters in Grimm's fairy tales, a coffee-room for non-smokers, an open-air smoking apartment, besides the regular smoking-room, drawing-room, and ladies' room, with which other first-class liners are provided. There is a post-office on board, with several postal officials in charge, and the mails will be sorted during the passage and landed at the port of arrival, ready for immediate delivery. The ship is also equipped with a wireless telegraph apparatus.

The bulkheads which divide the ship into compartments have watertight doors, which can be closed by a hydraulic system operated from the bridge, and in the wheel-house there is a board with small incandescent lamps which show whether the watertight doors are open or shut. The vessel is, of course, completely lighted by electricity; there are electric heaters in the staterooms, and there is a telephone central station which puts the staterooms and all other parts of the ship in immediate communication with each other.

The engine-room is made up of four separate compartments, divided by longitudinal and transverse bulkheads, with a complete engine in each, balanced on the Yarrow-Schlick-Tweedy system. There are two propeller shafts, and two engines are arranged in tandem on each, a stuffing-box coupling being used on the crank-shaft where it passes through the transverse watertight bulkhead separating each pair of engines. This arrangement is novel on transatlantic liners, although it has been adopted on some warships, as, for instance, the United States armored cruisers "New York" and "Brooklyn." On these latter, however, the after engines alone were used for cruising, and the forward engines were supposed to be coupled up when the maximum speed was needed. As a matter of fact, when the emergency arose, at the battle of Santiago, more time would have been lost in coupling up than gained by the increased power, and so the forward engines were never used during that historic engagement.

On the "Kaiser Wilhelm II.," the engine in each compartment is a complete quadruple-expansion, four-cylinder unit, and its contract indicated horse power, as given out by the company, is 10,000, although it will undoubtedly prove to be greater when the engines have found themselves. This is shown by a comparison between the engines of the "Kaiser Wilhelm II." and those of the "Deutschland." The engine on each shaft of the "Deutschland" consists of two 36.6-inch high-pressure cylinders, one 73.6 first intermediate, one 103.9 second intermediate, and two low-pressure cylinders 106.3 inches in diameter, the common stroke being 72.8 inches. On each shaft of the "Kaiser Wilhelm II." there are two 37.5-inch high-pressure cylinders, two 50-inch first intermediates, two 75-inch second intermediates, and two 112.2 low-pressure cylinders, their common stroke being 70.8 inches. The steam pressure in both cases is the same, 213 pounds to the square inch. Now, the engines of the "Deutschland" have always indicated much more than contract power, the greatest average for the whole trip being 37,500 or 4,500 more than the contract. The contract calls for 40,000 horse power in the "Kaiser Wilhelm II." and probably toward the close of the season she will be averaging considerably above this, and her speed may run as high as 23.75 or 24 knots an hour.

There are two propellers, each 22 feet 10 inches in diameter. The driving shaft is 230 feet long and weighs 253 tons, the

weight of the crank-shaft alone being 108 tons 15 hundredweight. To condense the huge volumes of steam that are delivered to the condensers requires 46½ miles of condenser tubes. The vessel has nineteen boilers, twelve of which are double ended and weigh, when empty, 114 tons apiece. The total heating surface of these boilers is over 2½ acres. The coal bunkers have a maximum capacity of 5,239 long tons of coal, and the coal consumption is about 650 tons per day. For bringing the coal from the bunkers to the furnaces, there is a narrow-gauge railroad track 200 yards long.

The dynamo-room is situated abaft the engine compartments, the generators being direct driven by their own engines and grouped between the propeller shafts, which pass through the compartment. On board the ship there are seventeen powerful steam pumps, capable of raising over 2,000,000 gallons per hour. The anchors weigh 23½ tons, and the chain cables and hawsers are over a mile in length.

Such is an outline of some of the features of this truly remarkable vessel. After inspecting her one is tempted to say, in the first flush of enthusiasm, that she is pretty near the superior limit of naval architecture and marine engineering, but it is always dangerous to prophesy, and perhaps before the "Kaiser Wilhelm II." is much older, another record breaker will appear on the seas. But she will have to be a good one.

ALCOHOL MOTORS.

DATA AND RESULTS OF TESTS MADE AT THE EXPERIMENTAL STATION OF THE EXHIBITION OF 1902, AT PARIS.

Max Ringelmann—Revue de Mécanique.

WE have already referred in these columns to the developments in the use of alcohol as a source of light, heat, and motive power, as indicated by recent investigations in France, and now we have an elaborate discussion by M. Max Ringelmann of the tests made upon internal-combusion motors using alcohol as fuel during the competition following the exhibition of 1901, and held in the Grand Palais des Champs Elysées in 1902. This paper, which is published in the *Revue des Mécanique*, examines principally the performances of stationary motors, together with those intended for portable use, giving curves showing comparative performances, and also discusses generally the subject of the commercial availability of alcohol as a fuel for power purposes, a question at present widely considered on the continent.

The principal object of these tests, and indeed of the entire exposition, was to demonstrate the practicability of using alcohol as a fuel, and to indicate the most efficient methods by which it may be employed, the purpose being to aid in developing a national industry of much importance. The trials were made with two varieties of fuel, one being pure alcohol "denaturé," or simply rendered unfit for human consumption by the addition of a slight amount of benzine, or similar substance, and the other being an alcohol combined with 50 per cent. of hydrocarbon, usually benzine or coal-tar naphtha. According to the computations based on chemical analysis, the pure alcohol has a calorific value of 5,521 calories per kilogramme, while the carburetted alçohol has a value of 7,453 calories per kilogramme, the former thus having but 74 per cent. of the value of the latter, but at the same time being but 80 per cent. of the cost. The results of a number of tests of motors with both fuels showed that the consumption of carburetted alcohol for the same power generated was about 70 per cent. of the consumption of pure alcohol, and that figure was therefore used in the tests in reducing to a comparable basis the performance of motors employing the two fuels.

The trials which form the basis of the paper of M. Ringelmann were made upon 42 motors representing 25 different makers, practically all of the better known French builders of internal-combustion motors, as well as some from Germany and Switzerland. The modifications necessary to enable the alcohol fuel to be used are principally in details of mixture, compression, and ignition of the charge, and hence this

permitted existing patterns to be used to a great extent. These machines were divided into classes according to the power developed and also according to the weight per horse-power developed. Nearly all the motors exhibited and tested were for stationary service, but a few were of the portable type, capable of being transported from place to place, and adapted for operating pumps, threshing machines, dynamos, etc.

The stationary motors varied in size from 1 to 35 horse-power, the greater number ranging from 5 to 10 horse-power, single and double-cylinder machines being represented, ignition being effected both by electricity and by the hot tube. In the original paper the tests are tabulated in full by groups, showing the performance both with pure alcohol and with the 50 per cent. carburetted mixture, the collected results being given graphically as well. For these details the reader must be referred to the article of M. Ringelmann, but the general conclusions may be given here to some extent.

The earlier trials of internal-combustion motors using alcohol showed that the machines operating at high rotative speeds, as arranged for use with automobiles and launches, were more economical than the larger and slower stationary engines. For this reason the motors were tested in groups, according to size, this rendering the results more readily comparable. In several instances the motors were constructed with variable compression, in order that the best proportion might be attained experimentally, although the results of such variations do not appear in the records of the trials.

When the mixed alcohol and benzine fuel was used, the motors were started as readily as in the case of the ordinary gasoline motors, but with the pure alcohol it was found desirable to use the mixed fuel for starting, and to have the connections so arranged that the heat of the exhaust pipe warmed the incoming charge.

When such motors are well designed and operated there is little or no odor produced in the discharge gases, the regulation is fairly uniform, and there is no fouling of the valves. When, however, the air supply is excessive, or the carburetting is imperfect, incomplete combustion follows, while excessive pressure or temperature is liable to produce a decomposition of the alcohol, causing the formation of various products, such as acetic aldehyde, ethane, acetic acid, methane, naphthaline and rarely formaline. More or less acetic acid is always found in the exhaust, and is liable to corrode the valves and valve-seat, and hence it is desirable to inject a small quantity of oil when the motor is left standing.

The most important element in alcohol motors lies in the carburetter, since the proper relation must be maintained between the volume of air admitted and the carburetting surface in order to secure the constant proportion of the charge. There is manifest room for improvement in this portion of the apparatus, since with the different carburetters of even the best makers, quite variable results were experienced. It must be understood that the liquids are not gasified, there really being formed a mixture of combustible vapors of varying tensions, frequently containing liquids in a state of pulverisation.

The tests included researches into the proper proportion of air to produce the best effects, and according to the analyses of M. Sorel, by whom this portion of the work was conducted, the highest economy was attained by the admission of about 50 per cent. excess air over that theoretically required for the complete combustion of the total carbon in the charge. If this proportion of air is diminished the proportion of unburned carbon in the exhaust increases very rapidly, this point being of much importance in connection with the economical performance of the motor.

In general the consumption of alcohol, carburetted with 50 per cent. of benzine, ranged from 0.233 kilogrammes per horse-power hour, to 0.645 kilogrammes, the mean being 0.433 kilogrammes, the price of the fuel being 0.468 franc per kilogramme in Paris.

From this it will be seen that the cost of a horse-power for a working year of 3,000 hours will average 607.9 francs, which compares favorably with the cost of power developed by steam engines of like dimensions.

The attention which is being given to the subject of the utilization of alcohol as a fuel for motive power is indicated by the exhaustive character of these tests, and the information derived from them should also aid in the improvement of the internal combustion motor in general.

PROGRESS IN ELECTROCHEMISTRY.

AN ADDRESS ON THE PRESENT STATE OF ELECTROCHEMISTRY AND THE CONDITIONS FOR ITS FURTHER PROGRESS.

Joseph W. Richards—American Electrochemical Society.

THE science and the art of electrochemistry have made such great advances of late years, and in America its practical applications in particular have increased so largely, that the rapid growth and the marked prosperity of the American Electrochemical Society, which have been already commented upon in these columns, while subjects of congratulation, are not to be wondered at.

It is, therefore, in a justly optimistic spirit that Prof. J. W. Richards, at the third general meeting of the American Electrochemical Society, recently held in New York, delivered his presidential address on the conditions which make for progress in science in general and electrochemistry in particular.

Science advances in many different ways, along many different paths and by many different agencies, but for the purposes of his discussion he classifies this progress under six headings: 1. Discovery of new facts. 2. Clearer understanding of the laws correlating facts. 3. More rational theories of the why and wherefore. 4. Increasing application of the facts to the welfare of mankind. 5. Increasing dissemination of scientific literature. 6. An increasing vision, on the part of the scientist, of the possibilities of scientific achievement.

The discovery of new facts may be regarded as the corner stone of progress in electrochemical, as in every other science. Given a freshly flowing current of new electrochemical facts, all the other elements of progress are vitalized. The birthplaces of these facts are the chemical, physical and electrical laboratories of universities, industrial corporations and individuals, and the sponsors are the investigators—professors, students, employees and individual seekers after knowledge. The elect among these workers are the professors of electrochemistry provided with well-equipped electrochemical laboratories. They are in a position to make or to direct the most valuable investigations, and the labors of such workers, given to the world in their publications, form the body of electrochemical science.

The German-speaking countries alone count up at their universities and technical schools fifteen chairs of electrochemistry and twelve electrochemical laboratories, and these have been the source of the greater part of the advance in electrochemical science in recent years. While America has been actively engaged in the development of electrochemical industries, there has not been so much work done in the purely scientific branches, but in place of professors and college laboratories, this country possesses another class of investigators who are no less industrious in acquiring facts and to whom a large part of America's commercial success is directly ascribable. These are the men in the laboratories of our industrial plants, who are searching over ground not yet explored and accumulating facts of value in their special industrial lines. The expense of such work is borne by the corporation for which they labor, and the work itself is in reality an investment made in the hope of yielding financial reward. Such workers frequently discover important facts, but by the nature of their employment they are generally not at liberty to publish their discoveries. Prof. Richards thinks, however, that when such researches have achieved their financial purpose, the scientific results should be given to the world. In other words, when the laboratory experiments have led up to the technical process and the latter has been protected by patents, then the scientific principles discovered during the investigation should be published. As to the when and the how, as well as the extent of such publication, the investigator and his employer are the proper judges, and the matter must be left to their discretion. But if they appreciate as they should the debt which they owe to the science as a whole, they can be safely trusted with deciding the question honestly and fairly to all interested and concerned.

By a careful and systematic study of facts we may learn the so-called laws of a science, which are really concise statements of the procedure of phenomena, or, in other words, scientific laws state briefly that, given certain causes, certain effects will result. Such generalizations may be made by the student and philosopher as well as by the original experimenter, and, in fact, the former is perhaps in a better position to take a broad view of the domain of science than the investigator, who is intensively cultivating only a small part of the field.

As soon as facts are discovered and laws are discerned, the scientist inevitably begins to reflect on the why and the wherefore. He commences to search for relations, to imagine connections and dependencies, and to make pictures of the mechanism of the phenomena. It was thus that Dalton imagined the atomic theory to account for the fact of chemical combination in simple multiple proportions, that Arrhenius hit upon the dissociation theory to account for the increase of molecular conductivity with increasing dilution, that Nernst worked out the solution-pressure theory to explain the generation of current in the galvanic cell.

Such theories are not only allowable, but necessary. They help us to handle mental conceptions as if they were concrete things, and thus to imagine and discover relations and generalizations which would otherwise be beyond our mental grasp. But if science is to progress, theories must progress, too. Probably all theories have been of some use in their day. But when their day has past, they must be modified to suit new requirements, or they may even have to be discarded altogether. If new facts appear which contradict even our most cherished theories, those theories must give way to the march of progress and be replaced by new ones which harmonize with the facts.

In order not to become a mere code of observed and classified facts, a thing to interest men by its intrinsic perfection, but of no other earthly use, a science must find practical applications which increase the comfort and well-being of mankind. In this respect electrochemistry is by no means lacking, it abounds in notable practical achievements, and electrochemical industries are becoming of greater and greater importance.

A great impetus has been given to this development by the utilization of waterfalls to drive electric machinery, and so furnish an economical source of power. But this question of cheap power may be given undue importance, for while in some processes the cost of power may be three-quarters of the total expense, in others it may be only one-quarter, or less, so that there may well be other considerations which will determine the location of an electrochemical plant. Other things being equal, however, the power question will, of course, be decisive, and for this reason Niagara Falls has become such a great electrochemical center.

But besides falling water, there is another source of cheap power which is widely distributed, but which, in America, has hardly been touched. This is the power which may be developed by the use of blast-furnace gas in gas engines. Prof. Richards estimates that there are thus scattered over the United States, in some of the most flourishing industrial centers, undeveloped powers which aggregate over 1,000,000 horse power, which can be developed at no more cost than the average water-power, and can be generated just at the spots where they can be most favorably utilized, and without any more drain on the country's natural resources than the harnessing of a new water-power, for not a pound of coal more would have to be burned than is used at present.

The industrial advance of electrochemistry is best promoted by the intimate and cordial co-operation of theoretical and practical electrochemists. Such co-operation is found in electrochemical societies and in research companies. These latter organizations, formed explicitly to combine research with practical application, are novelties in the industrial world which have originated with, and are almost peculiar to electrochemistry. They invent, investigate and develop apparatus, methods and processes, and furnish facilities to experimenters whose ideas might otherwise be stillborn.

No modern science can progress if it adopts the mediæval custom of the alchemists and carefully guards its knowl-

edge for the exclusive use of the initiated, but there is no lack of scientific literature nowadays. The real difficulty is for any technical man to keep well posted in the literature of even a single branch of science, and it is becoming more and more necessary for scientific and technical literature, whether in the form of books, periodicals or the transactions of societies, to be systematically classified and indexed, so that the seeker for information can get at what he wants without an expensive and exhausting search through great masses of printed matter.

In every field of human endeavor, for the teacher in his classroom, the writer at his table, the editor at his desk, the workman at his labor, the investigator at his task, the chief incentive to happy, productive work is the vision and promise of what may be attained. And so in electrochemistry, whatever brightens that vision and brings nearer the fulfillment of that promise is of the highest value to the science. This is the chief mission of society meetings, which by the free interchange of thought, the sharing of ideas, the communication of insights into the possibilities of science, quicken the enthusiasm and strengthen the spirits of the members, so that they derive fresh courage and inspiration for their life work.

THE CURTIS STEAM TURBINE.

A DISCUSSION OF STEAM TURBINES, WITH SPECIAL REFERENCE TO THEIR ADVANTAGES FOR DRIVING ELECTRIC GENERATORS.

W. L. R. Emmet—American Philosophical Society.

PROBABLY the most important features of steam engineering at the present day are the rapid commercial development of the steam turbine and its largely increasing use as a prime mover for electric generators.

The steam turbine has peculiar advantages for the direct driving of electric mahinery, and it occupies remarkably little space in proportion to its power, a matter which is of increasing importance in central stations for large cities. These and other characteristics have fixed the attention of electrical engineers upon the steam turbine, and its present rapid exploitation is largely due to the efforts of the manufacturers and users of electrical apparatus.

Up to the present time, the most important types of steam turbines have been the De Laval and the Parsons. In the former, the steam jet from a specially designed nozzle is directed against a set of vanes on a disc, to which is imparted a very high rotative velocity. With these extreme rotative speeds, the problem of balancing becomes vital, and it is practically solved by the use of the De Laval flexible shaft, which permits the moving parts to adapt themselves automatically to the axis of rotation. But even the very high speeds of this turbine fall short of the theoretically most efficient velocity, which, as is well known, is one-half of that of the jet of steam impinging upon the wheel, and at the same time, the speeds are too high for dynamos to be driven without intermediate gearing.

In the Parsons turbine slower speeds are secured without loss of efficiency by conducting the steam in an axial direction through a series of vanes arranged in fixed and moving circles alternately. In this way, the steam expands successively and imparts its energy to the moving parts. While this type of turbine has proved very successful for electric generation, and is being extensively used, it has a great multiplicity of parts and requires extreme care in its construction.

Other types and modifications of these forms are being introduced in Europe, and in America the principal newcomer is the Curtis steam turbine, which was invented several years ago, and which has been developed commercially by Mr. Curtis and the engineers of the General Electric Company. This turbine is described in a paper by Mr. W. L. R. Emmet, read recently before the American Philosophical Society, and reprinted in the *Electrical World and Engineer* and other journals.

The Curtis turbine has some of the features of its predecessors, but introduces new ones which, it is claimed, make possible lower speed, less weight, fewer and simpler

parts, higher economy, and other advantages.

"Velocity is imparted to the steam in an expanding nozzle so designed as to efficiently convert nearly all the expansive force, between the pressure limits used, into velocity in the steam itself. After leaving the nozzle, the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements, the velocity acquired in the nozzle is fractionally abstracted, and largely given up to the moving element. Thus the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means a high steam velocity is made to impart motion efficiently to a comparatively slowly moving element. The nozzle is generally made up of many sections adjacent to each other, so that the steam passes to the wheels in a broad belt when all nozzle sections are in flow.

"This process of expansion in nozzle and subsequent abstraction of velocity by successive impacts with wheel vanes is generally repeated two or more times, the devices for each repetition being generally designated as a stage. There may be various numbers of stages and various numbers of lines of moving vanes in each stage. The number of stages and the number of lines of vanes in a stage are governed by the degree of expansion, the peripheral velocity which is desirable or practicable, and by various conditions of mechanical expediency. Generally speaking, lower peripheral speeds entail more stages, more lines of vanes per stage, or both. The general practice is to so divide up the steam expansion that all stages handle about equal parts of the total power of the steam. The losses and leakages of the earlier stages take the form of more heat or more steam for the later stages, and are thus in part regained. Much water of expansion, which might occasion loss by re-evaporation, is drained out of each stage into that which succeeds it.

"The governing is effected by successive closing of nozzles and consequent narrowing of the active steam belt. In the process of governing, the nozzles of the later stages may or may not be opened and closed so as to maintain an adjustment proportional to that of the first stage, which is always the primary source of governing. Some improvement of light load economy may be effected by maintaining a relative adjustment of all nozzles; but in many cases the practical difference in economy is not great, and automatic adjustment of nozzle opening in later stages is dispensed with in the interest of simplicity. In some machines an approximate adjustment is maintained by valves in later stages, which open additional nozzles in response to increase of pressure behind them. These are used as much for limiting the pressures in stage chambers as for maintaining the light load economy.

"One of the most important advantages of the Curtis turbine is the high steam economy which it affords under average conditions of service. This economy is shown by curves of water consumption, which are derived from actual tests of the first commercial machine of this type which was completed. This machine drives a dynamo of 600-kilowatts capacity, and the curves give its performance at 1,500 revolutions per minute, which corresponds to a peripheral velocity of about 420 feet per second. These curves show a very high efficiency at light loads and at overloads as compared with results obtainable from steam engines."

Other curves show the effect upon steam consumption of changes in the steam pressure, the degrees of superheat and in the vacuum, and it appears that the superheat and vacuum curves are straight lines so inclined as to indicate a great benefit in superheating highly and in the use of a high vacuum. Steam turbines are peculiarly fitted to take advantage of these conditions; they have nothing which is injured by high steam temperatures, and they can be so constructed that leakage into the vacuum chamber is rendered impossible. No oil comes into contact with the steam, and, consequently, condensed water can be taken from surface condensers and returned to boilers. The use of surface condensers under such conditions renders unnecessary the introduction of air either in feed or circulating water, and so makes

possible a very high vacuum with small air-pumping apparatus.

A 5,000-kilowatt Curtis turbine is soon to be put in operation in Chicago, and it is expected that the variation in its efficiency, from half load to fifty per cent. overload, will not exceed three per cent. These turbines, when combined with an electric generator, are mounted on a vertical shaft, and consequently take up comparatively little floor space. In Mr. Emmet's paper there are illustrations of such a unit and of one of the same capacity, driven by a Corliss engine, in the Manhattan Railway Company's power station. The difference in size is striking, and it is stated that the respective weights of these two units, exclusive of foundation, are in the ratio of 1 to 8, while the saving in foundations is great.

"If the extreme simplicity of the Curtis turbine is considered in combination with these figures and comparisons, it is easy to appreciate that a very great engineering advance has been accomplished. It has been conservatively estimated that engine units, like those in the Manhattan Company's station, can be replaced by turbines like that in Chicago, and that the cost of such replacement can be paid for by saving in operating expenses in three years."

ELECTRIC STATION DEVELOPMENT.

MULTIPLE VERSUS INDEPENDENT OPERATION OF CENTRAL STATIONS, AND ECONOMICAL AND SAFE LIMITS IN THEIR SIZE.

American Institute of Electrical Engineers.

HAS the size of central stations reached its economic limit? This question, in a day of consolidation and aggrandizement, may seem to imply a lack of faith in modern engineering, but it is forced upon one by a recent discussion before the American Institute of Electrical Engineers following the reading of papers by Messrs. H. A. Lardner, Philip Torchio and Peter Junkersfeld.

Mr. Lardner's paper was on the "Economical and Safe Limits in the Size of Central Stations," and in it he discussed broadly the advantages and disadvantages of large central stations, with special reference to the conditions existing in cities of the first rank.

"The system of distribution which must be used, frequently has a direct bearing on the demand for a large station. Where the distribution pressure is low, as in Edison three-wire 120-240 volt systems, there are few if any cities where a sufficient load can be found for a very large station without exceeding the limited zone of economical distribution at this pressure.

"Where this system is in operation we find that the stations are generally of high first cost and too small to be operated economically. The location is necessarily chosen without regard to the water or coal supply, and the load factor is generally very bad, which adds to the expense of operation. As a temporary expedient, at least, rotary converters, transformers and high pressure cables have found a place for connecting together the direct current stations and thus enabling them to exchange power and considerably improve their load factors.

"The next step is to establish a large well-located alternating-current station and feed the rotaries from the machines there installed. This method permits the use of the largest size of generating units and gives their attendant economies, and the demands of the various sections of a city coming at different hours of the day produces a better load factor.

From many tests which have been made on steam engines, it has been found that the steam consumption of properly designed and operated engines of capacities as low as 500 horse power compares very favorably with that of the largest sizes used in central stations.

"That part of the cost of labor for engine operation, which varies with the size, amounts to but a small portion of the total operating expenses; and although the larger the unit, the smaller the item becomes per h.p. hour, it is relatively of little importance, except in very small units."

The necessity for the most economical use of floor space in large cities favors the employment of large units, but as a mat-

ter of fact, the floor space per horse power is affected more by the type of engine and the judgment of the designer than by the size of the unit, and with the advent of the steam turbine it becomes possible to nearly double the power of a central station without increasing its dimensions.

The advantages of large central stations may be summed up as follows:

"The location of the station on the one most suitable site for the coal and water supply.

"The reduction of floor space by the use of large units.

"The economy of fuel secured by the use of large generators and engines.

"The economy of labor and general superintendence secured by the use of large units in one building.

"The saving in first cost effected by the installation of a large station with large units.

"The economy of operation secured by serving many sections of a city with different hours of maximum demand from one station, due to the better load factor obtained.

"The installation of a large station presupposes supplying a very large territory from one source, and in order that the coal and water supply may be convenient, the chosen location is generally much farther from the load than when it is divided among several plants. This involves a greater expense for a distribution system, although this may be minimized by the installation of high potential current or by local conditions.

"The economy of floor space by the use of large units will always be an important consideration where land is valuable, but the economy in this direction with the steam turbine may lead the designer of the future to give less consideration to this point.

"It is a question whether there is any saving in the first cost in the installation of very large stations, except in prime movers and generators. The construction of double- and triple-decked boiler rooms, large coal handling apparatus and coal pockets high above the ground, involves heavy expenditures without compensating advantages. It is probable in the case of some large stations in this city that they could have been built to half their capacity as cheaply per unit as to the ultimate size. The size of the units in either case would probably have been the same.

"The principal disadvantage of the very large station is the danger to a system if the disabling of the station leaves the company without a source of power, or takes away a larger portion of its supply than can be cared for by overloading the remaining plants."

While the leading modern central stations are fine examples of careful attention to all features which make them reliable in operation and free from danger of breakdowns or interruptions to service, it is practically impossible to eliminate every weak point, and the larger the station and the greater the district which it serves, the more serious becomes the consequences of any accident.

In Mr. Torchio's paper, he gives a long list of the modern devices employed in generating station, transmission lines and sub-stations to secure safety and reliability of operation. On looking over this formidable array of safeguards, there naturally occurs the question whether the advantages of centralization and of wholesale production of current are not secured at too great a cost in the necessary multiplication and refinement of safety devices to insure continuous operation.

These considerations lead Mr. Junkersfeld to advocate the independent or sectional operation of every central station system, so that if trouble occurs, it may be localized as far as possible. In systems of electric supply for large cities, embodying the latest practice, where high-tension alternating current is generated at the central station, transmitted to "rotary" substations, and thence distributed by mains and service wires, the links between the coal pile and the consumer are enumerated by Mr. Junkersfeld as follows:

"Steam supply. Generator, prime mover and auxiliaries. High-tension transmission lines. Sub-station apparatus. Low-tension feeders. Mains and services."

The causes of trouble in each of these links are discussed, and the necessary precautions to be observed are pointed out, and the conclusion is reached "that considering responsibility for the business and

return on investment, every central station system should be designed, if not for independent, at least for sectional operation. In the very large stations, the independent units from coal pile to distributing network, or to rails, should be effectively isolated to make a total shut-down practically impossible. The matter of independent, sectional or multiple operation at different hours of the day or days of the year is entirely one of local conditions, which may change frequently. Great care and constant attention is needed to maintain a fairly uniform and consistent coefficient of reliability on every part of the central station system. Independent and even sectional operation will mean a small sacrifice in operating costs. With a system properly designed, this matter, then, becomes to the central station management a plain business consideration: to take the risk of inferior service and possible shut-down, or to pay a premium in the form of very slight sacrifice in operating costs and thus obtain an additional safeguard for superior service to all such groups of customers as business requirements may demand."

MUNICIPAL ACCOUNTING.

SYSTEM AND UNIFORMITY IN ACCOUNTING AND THE COMPILATION OF STATISTICS THE FOUNDATION OF MUNICIPAL REFORM.

National Municipal League—National Conference for Good City Government.

FOR several years past, factories and other industrial establishments have been overhauling their cost-keeping and accounting systems as they have come to a realizing sense of the fundamental importance of these departments of manufacturing economics, and the commercial, or "production," or "modernizing" engineer has become a well-recognized institution. It is, therefore, not surprising that the attention of municipal reformers has been directed to the statistical and accounting departments of city administration, and at a recent joint meeting of the National Conference for Good City Government and the National Municipal League this subject of municipal accounting was reported on and discussed at considerable length, and an account of the proceeding has appeared in the *Engineering Record,* from which some extracts are taken.

The report of the committee on "Uniform Municipal Accounting" was presented by Dr. M. Hartwell, city statistician, of Boston. He deplored the fact that statistics in general as published at the present are not of great value, made a strong plea for better statistics in every department, and stated it to be his belief that municipal statistics should begin at home; that they should relate to the object and needs of local administration and be prepared with the primary purpose of enlightening a local public opinion and of serving local authorities as the basis of intelligent action. So long as a city does not know itself it cannot know other cities, nor compare itself with them, nor profit largely by their experience. The sooner our leading cities are led to insist upon having simple and intelligible financial and statistical reports furnished by their own servants for home use, the sooner will the public and official mind become responsive to demands for the adoption of more modern and scientific methods of bookkeeping and housekeeping by all cities; and the sooner will it become possible for the student of municipal affairs and for state and national officials and bureaus to secure from city officials and publications, such information as is usually unattainable now. The immediate prospects for gathering strictly comparable data throughout the wide range of activities common to cities is not brilliant.

Frederick A. Cleveland, Ph.D., of the University of Pennsylvania, outlined the "Chicago Accounting Reform" in part as follows: Within fifty years Chicago grew from a village to a municipality of 2,000,000; it began with a small town organization; as its population and territorial jurisdiction spread, these town governments were incorporated by consolidation rather than by readjustment and reorganization. The city finally came to include more than twenty separate taxing jurisdictions, over which it had little control, and between

ter of fact, the floor space per horse power is affected more by the type of engine and the judgment of the designer than by the size of the unit, and with the advent of the steam turbine it becomes possible to nearly double the power of a central station without increasing its dimensions.

The advantages of large central stations may be summed up as follows:

"The location of the station on the one most suitable site for the coal and water supply.

"The reduction of floor space by the use of large units.

"The economy of fuel secured by the use of large generators and engines.

"The economy of labor and general superintendence secured by the use of large units in one building.

"The saving in first cost effected by the installation of a large station with large units.

"The economy of operation secured by serving many sections of a city with different hours of maximum demand from one station, due to the better load factor obtained.

"The installation of a large station presupposes supplying a very large territory from one source, and in order that the coal and water supply may be convenient, the chosen location is generally much farther from the load than when it is divided among several plants. This involves a greater expense for a distribution system, although this may be minimized by the installation of high potential current or by local conditions.

"The economy of floor space by the use of large units will always be an important consideration where land is valuable, but the economy in this direction with the steam turbine may lead the designer of the future to give less consideration to this point.

"It is a question whether there is any saving in the first cost in the installation of very large stations, except in prime movers and generators. The construction of double- and triple-decked boiler rooms, large coal handling apparatus and coal pockets high above the ground, involves heavy expenditures without compensating advantages. It is probable in the case of some large stations in this city that they could have been built to half their capacity as cheaply per unit as to the ultimate size. The size of the units in either case would probably have been the same.

"The principal disadvantage of the very large station is the danger to a system if the disabling of the station leaves the company without a source of power, or takes away a larger portion of its supply than can be cared for by overloading the remaining plants."

While the leading modern central stations are fine examples of careful attention to all features which make them reliable in operation and free from danger of breakdowns or interruptions to service, it is practically impossible to eliminate every weak point, and the larger the station and the greater the district which it serves, the more serious becomes the consequences of any accident.

In Mr. Torchio's paper, he gives a long list of the modern devices employed in generating station, transmission lines and sub-stations to secure safety and reliability of operation. On looking over this formidable array of safeguards, there naturally occurs the question whether the advantages of centralization and of wholesale production of current are not secured at too great a cost in the necessary multiplication and refinement of safety devices to insure continuous operation.

These considerations lead Mr. Junkersfeld to advocate the independent or sectional operation of every central station system, so that if trouble occurs, it may be localized as far as possible. In systems of electric supply for large cities, embodying the latest practice, where high-tension alternating current is generated at the central station, transmitted to "rotary" substations, and thence distributed by mains and service wires, the links between the coal pile and the consumer are enumerated by Mr. Junkersfeld as follows:

"Steam supply. Generator, prime mover and auxiliaries. High-tension transmission lines. Sub-station apparatus. Low-tension feeders. Mains and services."

The causes of trouble in each of these links are discussed, and the necessary precautions to be observed are pointed out, and the conclusion is reached "that considering responsibility for the business and

return on investment, every central station system should be designed, if not for independent, at least for sectional operation. In the very large stations, the independent units from coal pile to distributing network, or to rails, should be effectively isolated to make a total shut-down practically impossible. The matter of independent, sectional or multiple operation at different hours of the day or days of the year is entirely one of local conditions, which may change frequently. Great care and constant attention is needed to maintain a fairly uniform and consistent coefficient of reliability on every part of the central station system. Independent and even sectional operation will mean a small sacrifice in operating costs. With a system properly designed, this matter, then, becomes to the central station management a plain business consideration: to take the risk of inferior service and possible shutdown, or to pay a premium in the form of very slight sacrifice in operating costs and thus obtain an additional safeguard for superior service to all such groups of customers as business requirements may demand."

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which there was no well defined method of co-operation. The financial side of the administration became unmanageable and the government in all its activity was crippled.

Investigations lasting several months were made, and it became evident that municipal reform must begin with the accounts, in order to reduce them to such order as to make the data available as a basis for political action and administrative control. A report having been laid before the mayor, an ordinance was drafted and passed authorizing an accounting firm to install a new system of accounts and to supervise its operation during the first year after installation. The features of the new system as set forth by the official report of the controller are as follows:

Uniformity in accounting methods.

Concentration of the accounting in the controller's office.

Collection of all revenues by the city collector.

Daily remittances.

Monthly reports and balances between the controller and all departments.

Monthly financial report of the controller.

Organization of an auditing bureau and of a methodical plan of auditing by officers retained specially for that purpose and independent of all departments.

Accruement of all revenues on the general books of the city, where they will always be evident as obligations due the city and unpaid.

Approval of all contracts and requisitions for supplies by the controller to prevent departments from incurring liabilities in excess of appropriation..

The issuance of all fiscal stationery, forms and receipts, consecutively numbered by the controller, and holding the departments responsible for their use or cancellation.

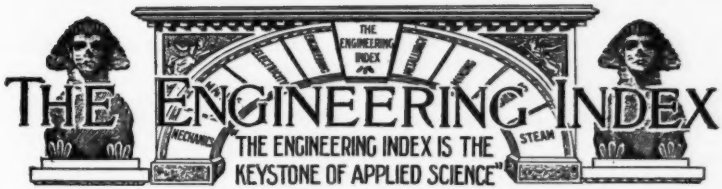
The use of graduated stubs or carbon receipts to check the collection of money.

The establishment of a complete chain of accounting from the inception of revenue or expense throughout the various branches of the city to the controller's office, where all the accounting is finally centralized.

All departments have been operating under this new system during the past year. The change from the old to the new was accomplished without confusion or detriment administration became unmanageable and the detailed workings of the new system have progressed without friction. It is now evident that the system has proved an advantage to the city government; has improved the efficiency of individual employees, and promoted an intelligent and interested direction of their efforts by departmental heads. The total of decreased expense and increased revenues seem to be close to a million dollars. From the point of view of municipal reform, the new system has laid the foundation for effective administration, and the reports based on this system give to the citizen a well classified digest of financial results, supplemented by schedules in sufficient detail to furnish a comprehensive knowledge of the affairs of the municipality. Taking the new system of accounting as a whole, it is a masterly piece of work; it may be said that Chicago has taken an advanced position worthy of emulation.

Mr. Harvey S. Chase discussed the progress of uniform municipal accounting in Ohio, outlining the steps taken to secure the passage by the Legislature of an act which created a "Bureau of Inspection and Supervision of Public Offices" under the Department of the Auditor of State. The bureau has had no precedent to guide it, for this is the first time that an entire state bookkeeping, including the accounts of large cities, has been overhauled and systematized.

Mr. Chase called attention to several important features of the National League's system, which had been incorporated by the state. The favorable reception which has been given to the bureau's schedule by the officials throughout Ohio has been very gratifying. The reports of the five largest cities of Ohio—Cleveland, Cincinnati, Columbus, Toledo, and Dayton, for the fiscal year 1902, are now nearly completed upon the new schedules. It must be recognized and remembered that the proposition before the bureau in Ohio is a vast one. It comprises not only the reorganization of the accounting and reporting in the cities, but likewise also for villages, townships, counties, school districts, and, in fact, for every taxing body in the state.



The following pages from a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals if the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

A Small Concrete Arch at West Hartford, Conn. Illustrates and describes a structure built without reinforcement of any kind. 600 w. Eng Rec—April 25, 1903. No. 54791.

Theory and Calculation of the Two-Hinged Spandrel-Braced Arch. Alex. Rice McKim. Presents a method by which the two-hinged arch can be constructed so that the stresses may be calculated with some degree of certainty of their being those of the finished structure. The article follows the lines of investigation developed by Mohr, Winkler and Mueller—Breslau. 4000 w. Eng Rec—April 11, 1903. No. 54688.

Bridge Engineering.

Essentials Necessary for Successful Practice in Bridge Engineering. J. E. Greiner. Extracts from a lecture delivered before the students of Cornell Univ. Emphasizes the need of continued study to keep pace with the times, and considers some points essential to success. 1500 w. Eng News—April 9, 1903. No. 54589.

Construction.

Types and Details of Bridge Construction. Frank W. Skinner. The first of a

We supply copies of these articles. See page 475.

series of illustrated articles presenting types of bridge construction and giving facts of interest in regard to the notable structures. The present article deals with arches. 2000 w. Eng Rec—April 1, 1903. Serial. 1st part. No. 54687.

Drawbridges.

Drawbridge Calculations. Edward Godfrey. Solves the problem by calculation of the deflections. 1300 w. Eng News—April 16, 1903. No. 54699.

Fort Dodge, Iowa.

The Des Moines River Viaduct of the Mason City & Fort Dodge R. R., at Fort Dodge, Iowa. H. C. Keith. A paper before the Iowa Engng. Soc. Describes the construction of a viaduct 2,582 ft. in length, consisting of 38-ft. towers, with 75-ft. suspended spans, and four truss spans of 220 ft. each. Ill. 2700 w. Eng News—April 9, 1903. No. 54587.

Highway Bridge.

A Steel Truss Highway Bridge with Concrete Floor. An illustrated description of a bridge under construction in Portage County, Ohio, of 100-foot span. 1000 w. Eng Rec—April, 25, 1903. No. 54789.

Manhattan Viaduct.

The Manhattan Valley Viaduct of the New York Rapid Transit Railroad. Illustrated detailed description of a viaduct 2174 feet in total length, which reaches from 125th street to 133d street and carries three lines of track. 2500 w. Eng Rec—March 28, 1903. No. 54445.

Newcastle-on-Tyne.

New Railway Bridge Over the Tyne. Illustrations and particulars of a bridge at Newcastle, for the North-Eastern Ry. Co. Caissons are described. 700 w. Engr, Lond—April 10, 1903. No. 54724 A.

Ouachita River, Ark.

The Ouachita River Bridge, Missouri Pacific Railway. Illustrates and describes a structure of interest owing to the range of rise and fall of water. 700 w. Ry Age—April 17, 1903. No. 54747.

Paderno Viaduct.

The Paderno Viaduct, Italy. An illustrated detailed description of one of the most harmoniously-proportioned of iron bridges in Italy, and of its construction. 2000 w. Engr, Lond—April 17, 1903. Serial. 1st part. No. 54952 A.

Quebec.

Anchor Approaches for the Quebec Cantilever. Brief illustrated description of this feature of the great 1800-ft. span cantilever bridge across the St. Lawrence. 600 w. Eng Rec—April 11, 1903. No. 54684.

Reinforced Concrete.

See Civil Engineering, Materials.

CANALS, RIVERS AND HARBORS.

Bizerta.

The Harbor Works at Bizerta and the Arsenal of Sidi-Abdallah (Rapport et Mémoire sur les Travaux du Port de Bizerte et de l'Arsenal de Sidi-Abdallah). Voisin Bey and Jean Hersant. An illustrated description of important harbor works in Tunis, particularly the making of huge concrete blocks, of 5000 tons, in caissons. 7000 w. Bull Soc d'Encouragement —March 31, 1903. No. 54842 G.

Buffalo.

The Buffalo Breakwater System. A brief history of Buffalo harbor and its protective works, with illustrated detailed description of the latest work. 4400 w. Eng Rec —April 4, 1903. No. 54557.

The New Buffalo Harbor Breakwater. Illustrations and particulars of this important engineering work. 1200 w. Sci Am—April 4, 1903. No. 54491.

Champlain-St. Lawrence.

The Projected Lake Champlain and St. Lawrence Ship Canal. E. G. M. Cape. Brief consideration of this project, with a discussion of its effect on freight from the Great Lakes. 900 w. Eng Rec—April 18, 1903. No. 54768.

Dredges.

Combined Bucket and Suction Dredger for Monte Video. An illustrated description of a dredger built for harbor works in progress on behalf of the Government of Uruguay. 1200 w. Engng—April 3, 1903. No. 54657 A.

Niagara River.

Damming the Niagara River at Buffalo. J. H. Massie. Remarks on the report of Maj. Thomas W. Symons favoring the building of a ship canal round the shoals and rapids, the causes of lowering of the water in Lake Erie, and the proposed remedy by damming the river. Ill. 1800 w. Eng Rec—April 18, 1903. No. 54766.

Panama Canal.

The Panama Canal. Continued discussion of paper by George S. Morison. 4000 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54972 E.

Pittsburg.

Improved Waterway Necessary for Commercial Outlet. Capt. W. B. Rodgers. A short paper on the need of improving the transportation facilities of Pittsburg, especially the navigation of the river. 1500 w. Pro Engrs Soc of W Penn—Feb., 1903. No. 54963 D.

Pittsburg—Her Waterways and Her Railways. Antes Snyder. Historical review of the development of this city, discussing transportation problems. 17500 w. Pro Engrs Soc of W Penn—Feb., 1903. No. 54962 D.

We supply copies of these articles. See page 475.

River Improvement.

The Economic Improvement of the Coosa and Alabama Rivers, in Georgia and Alabama. D. M. Andrews. A discussion of the problems in river improvement, and the best practice from the economic point of view. 3800 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54968 E.

Victoria Falls.

Water Power in South Africa. Francis Fox. Gives an account of the discovery and an illustrated description of Victoria Falls, reviews what has been done at Niagara and at other points in the way of utilizing water power, and considers the electrical development of these falls. 4200 w. Cassier's Mag—April, 1903. No. 54462 B.

Waves.

Tidal Waves, Seaquakes, and Storm Waves. W. H. Wheeler. Considers the causes of abnormal solitary waves and their effects, describing many such disturbances. 4000 w. Engr, Lond—April 17, 1903. No. 54951 A.

CONSTRUCTION.

Chicago Post Office.

The Dome Framing of the Chicago Post-Office Building. Illustrated description of the general details of construction of a steel framework dome 100 ft. in its greatest diameter. 900 w. Eng News—April 23, 1903. No. 54914.

Chimney.

A 165-Foot Concrete Chimney. James D. Schuyler. Illustrates and describes the construction of concrete-steel stacks in Los Angeles, Cal., and in New Jersey and Indiana. 2800 w. Eng Rec—April 11, 1903. No. 54685.

Concrete-Steel Chimney for the Pacific Electric Ry. Co., Los Angeles, Cal. Jas. D. Schuyler. Illustrated description of a notable piece of concrete construction, the erection, materials and method of working. 1700 w. Eng News—April 2, 1903. No. 54551.

Concrete.

Notes on Cement and Concrete Construction in the U. S. Government Fortification Work for 1902. Extracts from the report of the Chief of Engineers, U. S. A., showing devices and methods adopted by army engineers to meet severe requirements. Ill. 4800 w. Eng News—April 2, 1903. No. 54550.

Dams.

Dam Construction and Failures During the Last Thirty Years. C. Baillarge. Gives an analysis of the failures, showing where faulty construction was the cause. 5500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54543 D.

Exposition.

Engineering Work on the Louisiana Purchase Exposition at St. Louis. Information obtained during a recent visit of inspection, giving technical details of the engineering work in progress. Ill. 6400 w. Eng News—April 23, 1903. No. 54916.

Fire Prevention.

Fire Prevention and Fire Resistance. Horatio Porter. Considers the means employed for both purposes, their advantages and the difficulties. Also general discussion. 11000 w. Jour Ry Inst of Brit Archts—April 4, 1903. No. 54935 B.

Foundations.

Concrete Pile Foundations of the Hallenbeck Building, New York. An illustrated description of the system adopted for the addition to this building. 1200 w. Eng Rec—April 11, 1903. No. 54686.

Freezing Process.

The Depth of Freezing and the Loss of Cold by Conduction in the Freezing Process of Tunneling. Information given by Mr. Charles Sooysmith, based on records made at a mining shaft sunk at Iron Mt., Mich. 1000 w. Eng News—April 9, 1903. No. 54590.

Manhattan Life Building.

Enlarging and Remodeling the Manhattan Life Building. A description of this interesting engineering work, with illustrated details and methods of carrying out the work. 4800 w. Eng Rec—April 4, 1903. No. 54556.

Philadelphia Subway.

See Street and Electric Railways.

Piles.

Methods and Costs of Pile Pulling and Pile Blasting. Describes methods used, a sweep pile puller, a tripod pile puller, and the blasting out piles. Ill. 2200 w. Eng News—April 16, 1903. No. 54695.

Roads.

A Few Thoughts on Present Practice of Road Construction. James Owen. Considers briefly the construction, materials, practice, etc. 2000 w. Eng. Rec—April 25, 1903. No. 54788.

Massachusetts State Highways. A. B. Fletcher. On the work of the Massachusetts Highway Commission. 1200 w. Eng Rec—April 25, 1903. No. 54795.

New York State Aid Road Laws. An explanation of the Higbie-Armstrong law and the Fuller law. 1600 w. Eng Rec—April 25, 1903. No. 54797.

Road Laws of Illinois. Ira O. Baker. Briefly states the essential features of the laws relating to the construction and care of wagon roads. 2300 w. Eng Rec—April 25, 1903. No. 54794.

State Highway Laws of New Jersey. A

We supply copies of these articles. See page 475.

statement of the laws based on reports furnished by Henry I. Budd, the state commissioner of public roads. 2200 w. Eng Rec—April 25, 1903. No. 54796.

The Dirt Road. G. A. Roullier. Considers points often neglected, and gives suggestions for grading and drainage. 1100 w. Eng Rec—April 25, 1903. No. 54790.

The Use of Oil on Roads. Hiram M. Chittenden. From the "Report of the Chief of Engineers for 1902." Suggests points that should be investigated to determine its value, and gives results of its use in California. 1800 w. Eng News—April 23, 1903. No. 54920.

Simplon Tunnel.

The Simplon Tunnel and Its Consequences. Discusses the effect the opening of this line will have on the industrial progress of Italy; considers other engineering works planned, and the increase in traffic probable. 3000 w. Engr, Lond—March 27, 1903. No. 54502 A.

Steel Roads.

Progress of Steel Roads. Gen. Roy Stone. Reports concerning the steel road laid in Murray st., New York, and suggests the construction of automobile roads, and country highways, discussing the advantages of steel. 1300 w. Eng. Rec—April 25, 1903. No. 54799.

Tunnel.

Tunnel at Michel Creek Loop, Crow's Nest Pass Line, Canadian Pacific Ry. C. R. Coutlee. An illustrated account of the construction of a tunnel through loose gravel describing the methods and plant. 3800 w. Eng News—April 2, 1903. No. 54546.

The East Boston Tunnel. Reviews the scheme for rapid transit in Boston, and gives an illustrated description of this work of shield tunneling, now in progress. 3500 w. R R Gaz—April 10, 1903. No. 54591.

MATERIALS.

Cement.

Report of Committee on a Standard Specification for Portland Cement. Gives the specification and testing recommended. 3800 w. Can Soc of Civ Engrs, Adv Proof—Jan. 27, 1903. No. 54709 C.

The Raw Materials Employed and the Amount of Portland Cement Made from Each in the United States. Edwin C. Eckel. Gives a statement based upon very complete data, compiled and tabulated by the author, on the materials and methods at the various plants. 800 w. Eng News—April 16, 1903. No. 54696.

Bending Tests of Small Bars of Cement (Essais de Flexion sur des Barrettes Verticales de Ciment Soumises à un Effort Determinant dans leur Longeur un Moment Fléchissant Constant). L. Deval. An account of cement tests with small vertical bars to determine if breaking by a uniform bending moment is applicable to rapid cement testing. Curves and tables. 1600 w. Bull Soc d'Encouragement—March 31, 1903. No. 54846 G.

Concrete.

Comparative Tests of Limestone and Gravel Screenings and Torpedo Sand for Concrete. G. J. Griesenauer. Gives report of tests the results of which are uniformly in favor of screenings. 1400 w. Eng News—April 16, 1903. No. 54698.

The Use of Concrete in Architecture. David Gibson. Calls attention to some of the uses made of this material, and gives suggestions for its treatment. 1300 w. Munic Engng—April, 1903. No. 54600 C.

Concrete Beams.

Note on the Coefficient of Elasticity of Concrete and Mortar Beams During Flexure. E. J. McCaustland. Discussion of paper by Myron S. Falk, Jr. 1800 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54971 E.

Fireproofing.

"Ferroinclave," a New Fireproofing. Illustrates and describes a new plant of the Brown Hoisting Machinery Company, in Cleveland, Ohio, using this new material. 1300 w. Ins Engng—April, 1903. No. 54967 C.

Iron Protection.

A Comparison of Various Tests Applied to Paints Used for the Protection of Iron. Augustus H. Gill and Charles C. Johnson. An account of an investigation of the various methods used to test the value of paints, and a comparison of the paints themselves. 1200 w. Tech Quar—March, 1903. No. 54597 E.

Reinforced Concrete.

A Test for Reinforced Concrete (Eine Güteprobe für Eisen-Betan). Fritz v. Emperger. A discussion of tests of reinforced concrete and a plea for their standardization. Diagram and illustrations. 2800 w. Betan & Eisen—2 Heft, 1903. No. 54835 F + H.

Concrete with Transverse Reinforcement Compared with Hooped Reinforced Concrete (Beton mit Querarmatur, Verglichen mit "Béton Fretté"). L. A. Sanders. A description, with illustrations and table, of tests of concrete blocks reinforced transversely with many small bars. 1000 w. Beton & Eisen—2 Heft, 1903. No. 54836 F + H.

The Influence Lines of a Beam Fixed at

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Both Ends and Their Application to Compound Beams (Die Einflusslinien eines an den Beiden Enden Eingeklemmten Balkens und Ihre Anwendung auf Verbundbalken). Prof. G. Ramisch. A mathematical and graphical discussion of the bending moments and stresses in beams and the application of the results to reinforced-concrete beams. Diagrams. 4000 w. Beton & Eisen—2 Heft, 1903. No. 54838 F + H.

The Shearing Stresses in Reinforced-Concrete Beams (Die Schubspannungen in Betoneisenträgern). Dr. Max v. Thullie. A mathematical and graphical discussion of the shearing stresses in reinforced-concrete beams and of the results of some tests. 2500 w. Beton & Eisen—2 Heft, 1903. No. 54837 F + H.

Reinforced-Concrete Bridges of Limited Height over Railways (Wegüberführungen in Armiertem Beton bei Beschränkter Konstructionshöhe. Hr. Mörsch. An illustrated description of two small reinforced-concrete bridges for railway crossings in Germany. 1000 w. Beton & Eisen—2 Heft, 1903. No. 54833 F + H.

Reinforced-Concrete Bridges of the Jura-Simplon Railway (Note sur les Ponts Sous Rails en Béton de Ciment Armé Construits dès 1894 par la Cie. de Chemins de Fer Jura Simplon). E. Elskes. An illustrated description of Swiss railway bridges of reinforced concrete. 1 Plate. 1000 w. Beton & Eisen—2 Heft, 1903. No. 54834 F + H.

Ferro-Concrete Warehouse at Newcastle-on-Tyne. An illustrated description of a recently built warehouse on the Hennebique system. 1400 w. Engng—April 17, 1903. No. 54954 A.

Rusting.

Comparative Tests on the Rusting of Wrought Iron and Steel (Vergleichende Untersuchungen von Schweisseisen und Flusseisen auf Widerstand gegen Rosten). An abstract of Prof. Rudeloff's report in the Mitteilungen aus den Königlichen Technischen Versuchsanstalten" of elaborate experiments to determine the relative resistance to rusting, under various conditions, and with various methods of protection, of different kinds of iron and steel. 4000 w. Stahl u Eisen—March 15, 1903. No. 43829 D.

Slag Cement.

The Manufacture of Iron-Portland Cement from Blast-Furnace Slag (Die Verwertung der Hochofenschlacke zu Eisen-Portlandzement). Hr. Jantzen. Paper before the "Verein zur Beförderung des Gewerbfleisses," giving a historical and technical account of the manufacture of hydraulic cement from blast-furnace slag. Diagram. 8500 w. Stahl u Eisen—March 15, 1903. No. 54826 D.

Steel Cleaning.

Sand-Blast Cleaning of Structural Steel. Discussion of paper by George W. Lilly. 6500 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54970 E.

Steel Preservation.

Official Report on Preservation of Structural Steel in a Tall New York Building. Condensed Report of Jas. P. Whiskeman to the Superintendent of Buildings, in regard to the condition of the Pabst Building, recently demolished. Ill. 1800 w. Eng Rec—April 18, 1903. No. 54764.

Steel Specifications.

Recent Advances in the Standardization of Steel Specifications. Concerning the revised specifications adopted, comparing them with the previous standards. 3500 w. Ir Age—April 30, 1903. No. 54984.

Timber.

Notes on the Treatment of Timber. S. W. Labrot. A brief review of the various methods, and the cost. 1500 w. Ry & Engng Rev—April 18, 1903. No. 54743.

The Hardy Catalpa for Posts and Ties. Gives interesting facts in regard to the culture of these trees and their value. 2000 w. Eng Rec—April 18, 1903. No. 54771.

MEASUREMENT.

Base Line.

Base Line Measurements with Steel Tapes. Arthur D. Butterfield. Describes apparatus used, methods employed and results obtained by the writer. Ill. 3400 w. Jour Worcester Poly Inst—March, 1903. No. 54605 C.

Level.

The Gradient-Telemeter Level and Its Advantages on Preliminary Work. R. W. MacIntyre. Illustration, with description of this instrument and the principle upon which it works. 1800 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54544 D.

Level Rod.

A Rod for Rapid and Accurate Leveling. Illustrates and describes the Heghmian level rod and slope tape. Cut, fill or elevations are read directly from the rod. 1800 w. Eng Rec—April 4, 1903. No. 54558.

Stadia Lines.

Stadia Lines. H. Dennis Taylor. Describes the simple or direct method of applying stadia lines to instruments, and also the anallatic method. 1300 w. Engng—April 17, 1903. No. 54956 A.

Underground Surveying.

Errors in Underground Surveying with the Fast Needle. Discusses how errors oc-

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cur in the use of the vernier dial and how they may be avoided. 2400 w. Col Guard —March 27, 1903. No. 54508 A.

MUNICIPAL.

Factory Waste.

The Admission of Factory Wastes to the Sewers. Editorial discussion of English law in regard to sewage disposal. 1700 w. Engng—April 3, 1903. No. 54658 A.

Fire Apparatus.

Some Modern Appliances for Life Saving at Fires. Illustrates and describes mechanical and other devices used, and methods of rescue. 1200 w. Sci Am—April 4, 1903. No. 54489.

Havana.

Street Improvements in Havana. Charles E. McDowell. Brief description of the conditions and the proposed remedies. 800 w. Eng Rec—April 25, 1903. No. 54798.

Pavements.

Brick Pavements in Toronto. Charles W. Dill. Reports them as well adapted to this northern climate and gives the method of construction. Ill. 1300 w. Munic Jour & Engr—April, 1903. No. 54580 C.

Coal-Tar Pavements in Northern New England. Particulars in regard to a pavement laid in Hanover, N. H. Also information furnished by Prof. John V. Hazen in regard to similar pavements in other places. 1500 w. Eng Rec—April 25, 1903. No. 54793.

Kreodone Wood-Block Pavements. Frank W. Moulton. Describes the method of treating the block, and claiming remarkable wearing qualities. 1800 w. Munic Jour & Engr—April, 1903. No. 54583 C.

Refuse Destructors.

The Use of Refuse Destructors in Power Plants. States the requirements of a successful destructor; the methods of burning, types of furnace in use, and brief accounts of various works, mostly in England. Ill. 3500. Engr, U S A—April 1, 1903. No. 54574.

Sewage.

Sewage and Refuse Disposal. Describes the tanks, distributing chamber, sludge beds, etc., of the latest system of bacterial treatment of sewage in Great Britain. 3200 w. Munic Jour & Engr—April, 1903. No. 54582 C.

Sewage Pumping.

See Mechanical Engineering, Hydraulics.

Sewer Ventilation.

Ventilation of Sewers and Drains. R. Read. Read at Birmingham meeting of the English Assn of Munic. & Co. Engrs. Describes the practice in English cities, and some of the difficulties overcome. 3500 w. Munic Jour & Engr—April, 1903. No. 54581 C.

Sewers.

Concrete Sewers. Walter C. Parmley. Illustrates and describes a system of concrete and steel construction devised by the writer. 1000 w. Engng—April, 1903. No. 54599 C.

Sewer System for Indiana Harbor, Indiana. Otto Gersbach. Describes the plant of a town on Lake Michigan. 1200 w. Eng Rec—April 11, 1903. No. 54683.

Sidewalk Vaults.

The Misuse of Public Sidewalk Areas and Vaults. Reginald Pelham Bolton. Discusses some of the encroachments on the public property under sidewalks, and upon them. 1200 w. Eng Rec—April 18, 1903. No. 54767.

WATER SUPPLY.

Filtration.

The Marborough Brook Filter Beds. Walter W. Pach. Illustrates and describes the construction and operation of these filter beds, as an illustration of the application of the principles of slow sand filtration of water to a case presenting many unusual features. 3000 w. Eng News—April 16, 1903. No. 54697.

Fire Service.

The Quantity of Water Used for Fire Service in Madison. J. H. Neef. Gives a study of the Madison fires. 1500 w. Wis Engr—Feb., 1903. No. 54608 D.

London.

The Water Supply of the Metropolis. Reviews a report by Mr. Maurice Fitzmaurice on the conditions of the Thames and Lea, in relation to the water supply of the London district. 1800 w. Engng—April 10, 1903. No. 54729 A.

Organisms.

On the Practical Value of Presumptive Tests for Bacillus Coli in Water. George C. Whipple. Presented at New Orleans meeting of the Am. Pub. Health Assn. Describes method of making the tests, discussing the practical value. 4000 w. Tech Quar—March, 1903. No. 54596 E.

Vaulation.

A Water Works Appraisal at Mobile, Ala. Abstract of the report of a commission appointed to determine the value of a plant to be purchased. 7000. Eng News —April 23, 1903 No. 54915.

Waste.

Water Waste Investigations in New York City. A further report giving the results of eight districts, with particulars. 1500 w. Eng Rec—April 18, 1903. No. 54769.

We supply copies of these articles. See page 475.

Water Tower.

Water Tower, Westinghouse Works, Manchester. Illustrated detailed description of a tower constructed for the purpose of supporting two large tanks for the storage of a large volume of water under conditions of constant high pressure. 1000 w. Engr, Lond—April 10, 1903. No. 54722 A.

MISCELLANY.

Consulting Engineers.

Consulting Engineers and Their Work. Dr. Alexander B. W. Kennedy. Inaugural Address of the Session 1902-3 of the City and Guilds Central Technical College. On the duties and work of an engineer after his training is over. 5000 w. Engng—March 27, 1903. No. 54515 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

How Cables Are Laid, Worked, and Mended. J. W. Davis. A descriptive account of the work. 3300 w. Gunton's Mag—April, 1903. No. 54470.

Conduits.

Underground Conduits in Chicago. George W. Jackson. An illustrated article showing the extent and describing the construction of the underground conduits of the Illinois Telephone and Telegraph Company. 2800 w. Page's Mag—April, 1903. No. 54755 B.

Faller Telephone System.

The Faller Mechanical Telephone Operator. Frank C. Perkins. An illustrated description of an interesting invention by Ernest A. Faller. 900 w. Elec, N Y—April 1, 1903. No. 54475.

Philippines.

Telegraph Engineering in Moro Land. A short illustrated account, by a Signal Corps man, of the methods and working conditions under which military communication is maintained in field operations in the Philippines. 1400 w. Engineering Magazine—May, 1903. No. 54854 B.

Space Telegraphy.

Recent Application of the Braun-Siemens & Halske System of Wireless Telegraphy. E. Guarini. An illustrated account of German shore stations and military apparatus for the German Army, and a short discussion of the distinctive features of the Braun and the Slaby systems. 1200 w. Elec Rev, Lond—March 20, 1903. No. 54646 A.

The Development of Marconi's System of Wireless Telegraphy. Emile Guarini. An illustrated historical review of Marconi's work in this field. 1300 w. Sci Am Sup—April 25, 1903. 1st part. No. 54912.

The Lodge-Muirhead System of Wireless Telegraphy H. C. Fyfe. An illustrated detailed description of the installation in Kent, England. 1500 w. Sci Am—April 18, 1903. No 54737.

The Lodge-Muirhead Wireless Telegraph System. H. C. Marillier. An illustrated description of a system based on scientific principles. One of the valuable features is the direct application of ordinary telegraphic signalling apparatus, both at the sending and receiving ends. 2000 w. Elect'n, Lond—March 27, 1903. No. 54517 A.

"Wireless" Telegraphy. Ed. C. de Segundo. Discusses the present position of cables and "wireless" telegraphy from a commercial point of view, and the probability of long-distance cables being superseded by any wireless system. 4500 w. Page's Mag—April, 1903. No. 54756 B.

Wireless Telegraphy in the United States. E. Guarini. An account of Edison's system, presented in 1891; and of the designs of Phelps, Gilliland, and Tesla for communication between trains, are given in the present article. Ill. 1500 w. Elec Rev, Lond—April 17, 1903. Serial. 1st part. No. 54944 A.

Telegraphone.

The Telegraphone and the British Post-Office. Herbert C. Fyfe. An illustrated description of this instrument that records and reproduces the message spoken into it. 1200 w. Sci Am—April 25, 1903. No. 54911.

Telephone Exchanges.

Telephone Exchanges. Arthur V. Abbott. The present article deals with the sub-station and its apparatus. Ill. 3000 w. Elec Wld & Engr—April 25, 1903. Serial. 1st part. No. 54913.

A Central Energy Multiple Telephone System. E. T. Evans. Explains the operation of a system in use in an exchange having about 3000 subscribers. 2800 w. Am Elect'n—April, 1903. No. 54486.

Reconstruction of the National Telephone Co.'s Glasgow System. An illustrated description of the work. The method adopted is an adaptation of the "ringing through" principle to the central battery signalling system, used in connection with multiple switchboards fitted with branching jacks. 3200 w. Elect'n, Lond—April 17, 1903. No. 54947 A.

White House.

The New Telephone and Telegraph

We supply copies of these articles. See page 475.

Bureau at the White House. Waldon Fawcett. An illustrated article describing the fine equipment which is of such invaluable service to the President. 1200 w. Elec Rev, N Y—April 18, 1903. No. 54748.

DISTRIBUTION.

Circuits.

Circuits for the Transmission and Distribution of Electrical Energy. A. S. M'Allister. Describes an ingenious arrangement of interconnected circuits, and the behavior of the currents. 2500 w. Am Elect'n—April, 1903. No. 54482.

Switches.

Recent High-Voltage Switches (Neuere Hochspannungsschalter). A. Gerhardt. Illustrated descriptions of switches for electrical plants with high voltages. 2800 w. Elektrotech Zeitschr—April 9, 1903. No. 54818 B.

Wiring Rules.

The Institution of Electrical Engineers' New Wiring Rules. Gives a copy of the new set of general rules recommended for wiring for the supply of electrical energy. 6000 w. Elect'n, Lond—March 20, 1903. No. 54419 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Contribution to the Theory of the Lead Accumulator (Ein Beitrag zur Theorie des Bleiakkumulators). M. U. Schoop. An illustrated description of a method of measuring the internal resistance of lead storage batteries, an account of experiments, and a discussion of the relation between the apparent and the real active surface, and other points, with diagrams. 3000 w. Elektrotech Zeitschr—March 19, 1903. No. 54810 B.

Antimony.

The Electrolytic Production of Antimony. Abstract of an article by J. Izart, in the *Industrie Electrique*. A brief account of observations upon the electrometallurgical treatment of minerals containing antimony, describing methods. 1200 w. Elect'n, Lond—April 10, 1903. No. 54718 A.

Insulation.

Insulating Materials; A Field for the Chemist. Max von Recklinghausen. Read at the N. Y. meeting of the Am. Elec-Chem. Soc. Considers the desirable and undesirable qualities of insulating materials now used, showing where chemical research would be of value. 2000 w. Eng News—April 23, 1903. No. 54917.

Progress.

Conditions of Progress in Electro-chemistry. Joseph W. Richards. Classifies the progress made under six headings, discussing them seriatim. 5500 w. Am Elec-Chem Soc—April 18, 1903. No. 54980 D.

Recent Progress in Electro-Chemistry (Neuere Fortschritte der Elektrochemie). Prof. Alfred Coehn. An address before the "Elektrotechnischer Verein" on electro-chemistry and its practical applications, particularly in the preparation of organic products. 3000 w. Elektrotech Zeitschr—March 26, 1903 No. 54813 B.

Steel Manufacture.

The Electric Reduction of Iron Ores and the Conversion of Iron into Steel in an Electric Furnace. Louis Simpson. Concerning the quality and cost. 2200 w. Electro-Chem Ind—April, 1903. No. 54674 C.

Stray Currents.

Corrosion of Metals by Electrolysis. A. A. Knudson. Read at New York meeting of the Am. Elec-Chem. Soc. Calls attention to instances of corrosive effects from unintentional electric currents and presents considerations for their avoidance. Ill. 3200 w. Elec, N Y—April 22, 1903. Serial. 1st part. No. 54780.

See also Marine and Naval Engineering Corrosion.

ELECTRO-PHYSICS.

Condenser.

The Electrodynamic Condenser. James Swinburne. A further explanation of the principle of the "electro-magnetic condenser" referred to by the writer in his recent presidential address. 600 w. Elect'n, Lond—March 27 1903. No. 54516 A.

Electromagnetism.

The Contributions of H. F. E. Lenz to the Science of Electromagnetism. W. M. Stine. Reviews the history of the science in the present number, especially the investigations of Lenz. 5000 w. Jour Fr Inst—April, 1903 Serial. 1st part. No. 54461 D.

Electrons.

The Development of the Electron Idea. W. Kaufmann. Authorized translation of an address before the Gesellschaft Deutscher Naturforscher und Arzte. A summary of the electron theory up to date, tracing the history of the development of the electron idea. 5000 w. Elec Wld & Engr—April 18, 1903. No. 54752.

Induction Coil.

The Induction Coil. James Edmund Ives. A mathematical study of the theory of the induction coil. 2000 w. Elec Wld & Engr—March 28, 1903. No. 54447.

See also Mechanical Engineering, Automobiles.

Insulation.

Effect of High Potential Discharge on

Mica Insulation. John Härdén. Reports investigations which show that a solid insulation combined with mica in condensers, or similar appartus, would be most effective without the use of oil. 1200 w. Elec Wld & Engr—April 18, 1903. No. 54753.

Ions.

Some Effects Produced by Positive Ions. Prof. John S. Townsend. A statement of the writer's theory, with an outline of the method in which it has been experimentally verified. 1200 w. Elect'n, Lond—April 3, 1903. No. 54705 A.

Magnetism.

William Gilbert and Terrestrial Magnetism in the Time of Queen Elizabeth. Prof. Sylvanus P. Thompson. Address to the Royal Geog. Soc. An analysis of the work of Gilbert in this field, with reference to other investigators. 3300 w. Elect'n, Lond—April 10, 1903. No. 54717 A.

Radio-Activity.

Radium and Other Radio-active Substances, with a Consideration of Phosphorescent and Fluorescent Substances. The Properties and Applications of Selenium and the Treatment of Disease by the Ultra-Violet Light. William J. Hammer. 21000 w. Trans Am Inst of Elec Engrs—April 17, 1903. No. 54976 D.

The Spontaneous Disengagement of Heat by the Salts of Radium (Sur la Chaleur Dégagée Spontanément par les Sels de Radium). P. Curie and A. Laborde. An account of experiments which prove that radium salts emit heat continuously, these salts maintaining a temperature about 1.5° C. above surrounding objects. 600 w. Comptes Rendus—March 16, 1903. No. 54870 D.

On the Heat Developed Spontaneously by the Salts of Radium. P. Curie and A. Laborde. Abstract translation of paper read before the Académie des Sciences. An investigation of the heat-producing power of radium. 1500. Elect'n, Lond—April 3, 1903. No. 54704 A.

The Emanations of Radium. Sir William Crookes. Read before the Royal Soc. A report of experimental investigations. 1900 w. Elect'n, Lond—April 3, 1903. No. 54706 A.

Radiography.

A Personal Experience in Radiography, Together with the Technique of Stereoscopic Radiography. Alexander B. Johnson. Explains the important details and methods. 8500 w. Sci Am Sup—April 11, 1903. No. 54670

Wave Form.

The Cathode Tube Wave Indicator. George S. Macomber. Gives an illustrated description of a cathode ray tube outfit, indicating some of its uses. 1500 w. Sib Jour of Eng—April, 1903. No. 54629 C.

GENERATING STATIONS.

Berlin Store.

Power Plant with Mechanical Draft (Kraftwerk mit mechanischen Zug). E. Josse. An illustrated description of a steam, electric and mechanical plant in a large Berlin store, the boilers in the top story being operated with mechanical draft, and the engines and generators being placed in the basement. Serial. Two parts. 7000 w. Zeitschr d Ver Deutscher Ing—March 14, April 4, 1903. No. 54800 each D.

Design.

Points in the Design of a Power Plant. W. H. Booth. The present article discusses briefly boilers, steam engines and condensing plants, generators, and accumulators, with the general design. 2500 w. Elec Rev, Lond—April 17, 1903. No. 54946 A.

Detroit.

Power Department of Park, Davis & Co., Detroit, Mich. Illustrates and describes their steam and electric generating plant recently enlarged and improved. 3200 w. Steam Engng—April 10, 1903. No. 54630.

Double Generators.

Double Generating Sets (Ueber Doppelmaschinen, insbesondere solche in Schwungradanordnung). F. Collischon. An illustrated description of some Lahmeyer generating sets, in which two dynamos, furnishing different kinds of current, and acting as flywheels, are direct coupled to a steam engine. 1400 w. Elektrotech Zeitschr—March 26, 1903. No. 54811 B.

Earthing.

Notes on the Earthing of Dynamo-Electric Machinery. Arthur Bloemendal. Brief consideration of the question not only for low-pressure, but also for high-pressure installations. 1200 w. Elec Rev, Lond—March 27, 1903. No. 54519 A.

Electrical Energy.

The Development of Electrical Energy Supplies. Mark Ruddle. Read before the Dublin Local Sec. of the Inst. of Elec. Engrs. A discussion of matters pertaining to the economical generation and distribution of electrical energy. 3500 w. Elec Engr, Lond—March 20, 1903. No. 54415 A.

Flat-Iron Building.

Power Plant of the Flat-Iron Building, New York. An illustrated description of the fine plant installed in this rather unusual office building. 3500 w. Engr, U S A—April 15, 1903. No. 54744 C.

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Gas Engines.

An Application of Gas-Engines to Isolated Plant Work. An illustrated description of the power equipment of the Keystone Bank Building, Pittsburg. 1000 w. Am Elect'n—April, 1903. No. 54481.

Gold Mines.

Central Electric Power Stations for Gold Mines. J. W. Kirkland. Read before the Mech. Engrs. Assn. of the Witwatersrand. Points out mistaken principles in operating arrangements of deep-level gold mines, advocating centralization of power to the greatest possible extent and the distribution by means of electricity. 4800 w. Mech Engr—April 4, 1903. No. 54645 A.

Multiple-vs. Independent.

Multiple versus Independent Operation of Units and Central Stations. Peter Junkersfeld. Practical difficulties encountered in the operation of central station systems are discussed. An argument for independent or sectional operation. 6000 w. Trans Am Inst of Elec Engrs—April 24, 1903. No. 54977 D.

Niagara.

Six Niagara Power Installations Under Way—A Million Horse Power to be Developed at Niagara Falls. Frank C. Perkins. An illustrated article giving information relating to the power plants in process of construction, or projected, on the American and Canadian sides of the Niagara River, and how the power is to be utilized. 5500 w. Elec Wld & Engr—April 11, 1903. No. 54689.

Norway.

A Norwegian Water Power Plant. Franz Köster. Brief illustrated description of an interesting water power electrical generating plant recently completed at Hafslund, about 56 miles southeast of Christiania. 1200 w. Elec Wld & Engr—April 4, 1903. No. 54666.

Parallel Running.

Some Hints on the Care and Paralleling of Direct-Current Dynamos. Ralph Scott. Suggestions, describing methods of testing, &c. 1800. Am Elect'n—April, 1903. No. 54485.

Residence Lighting.

Electric Generator for Lighting Residence. Brief illustrated description of an installation for the lighting of a villa, and a number of domestic purposes; also furnishing the power for an automobile. 800 w. Sci Am Sup—April 18, 1903. No. 54740.

Rheostat.

See Electrical Engineering, Measurement.

Safety Devices.

Safety Devices in Central Stations and Sub-stations. Philip Torchio. Considers generally the characteristic features tending to increase the factor of safety and the reliability of operation. 2800 w. Trans Am Inst of Elec Engrs—April 24, 1903. No. 54978 D.

San Francisco.

Power Plant for the New Government Building at San Francisco. Illustrates and describes the plant for a building which is to serve the combined purposes of a court house and post-office, furnishing light, heat and power. 3000 w. Eng Rec—April 18, 1903. No. 54770.

See also Street and Electric Railways.

Size.

Economical and Safe Limits in the Size of Central Stations. H. A. Lardner. Discusses the advantages and disadvantages of large central stations; and the probable effect of steam turbine development on the size of generating units. 4000 w. Trans Am Inst of Elec Engrs—April 24, 1903. No. 54979 D.

Small Stations.

The Economical Design and Management of Small Central Stations. Considers some of the conditions of economical and efficient design and management of small electric light undertakings. 4200 w. Elec Eng, Lond—April 17, 1903. No. 54942 A.

Victoria Falls.

See Civil Engineering, Canals, Rivers and Harbors.

Willisden, Eng.

Electrical Extensions at Willisden. A detailed description of the engines and alternators added, explaining the conditions to be met. 1700 w. Engr, Lond—April 10, 1903. Serial. 1st part. No. 54721 A.

LIGHTING.

Arc Lamps.

Notes on Mechanical Details of Enclosed Arc Lamps. J. Pratt Sligh. Read before the Newcastle Local Sec. of the Inst. of Elec. Engrs. Gives an outline basis from which comparisons can be made of the suitability of any given lamp for the particular kind of work required. 4200 w. Elec Engr, Lond—March 20, 1903. No. 54416 A.

Some Notes on the Series Running of Arc Lamps of Rectified Currents. W. Rogers. Explains the mechanical method of obtaining a rectified current, describing the apparatus. Ill. 1700 w. Elec Engr, Lond—March 20, 1903. No. 54417 A.

Hoho Method.

The Principles of a New Method of Electric Lighting. Paul Hoho. Describes a method of obtaining light and very high temperatures by immersing a small sphere

of silicon dioxide and silicates in an electrolyte of bicarbonate of soda and potassium and passing an electric current. 2500 w. Elec Wld & Engr—March 28, 1903. No. 54448.

Lighthouse.

The New Electric Lighthouse on Helgoland (Das Neue Elektrische Schnellblinkfeuer auf Helgoland). O. Krell, Jr. A well illustrated description of the new Helgoland lighthouse, which has a revolving light with three beams projected from high-power electric search lights placed at angles of 120°, a duration of 0.1 second. 3000 w. Elektrotech Zeitschr—April 16, 1903. No. 54820 B.

Nernst Lamp.

The Nernst Lamp (Die Nernstlampe). Oskar Bussmann. A paper before the "Elektrotechnischer Verein," giving an illustrated account of the Nernst lamp as developed by the Allgameine Elektricitäts-Gesellschaft, with results of tests. The author is one of the chief developers of the Nernst lamp. 4000 w. Elektrotech Zeitschr—April 9, 1903. No. 54819 B.

Residence.

See Electrical Engineering, Generating Stations.

Street Lighting.

See Gas Works Engineering.

Theatre Plant.

The Electric Installation in the Prince Regent Theatre at Munich (Die Elektrischen Anlagen im Prinzregenten-Theater zu München). C. Arldt. A well illustrated description of a very complete stage and theatre electrical installation. 1600 w. Elektrotech Zeitschr—April 2, 1903. No. 54814 B.

Electric Installations in Theatres. C. Arldt. An illustration description of the installation in the Prince Regent Theatre, of Munich, as an example of recent practice. 1600 w. Trac & Trans—April, 1903. No. 54904 E.

Train Lighting.

An Axle-Light System of Train Lighting. Arthur J. Farnsworth. Gives reasons why axle-systems have theoretical possibilities of meeting the exacting requirements of the problem better than other systems, and gives an illustrated description of an axle-lighting system and its operation. 2400 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54776 D.

An Electric Car Lighting System. W. L. Bliss. Illustrated description of an axle-driven electric car lighting system in which the generator is located on the truck frame, the armature being rotated by means of a single reduction gearing. 5900 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54774 D.

Axle-Lighting. Elmer A. Sperry. A statement of some of the problems encountered in electric train lighting, criticizing some of the methods employed in solving these problems, and announcing a new system of axle-lighting. 2800 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54775 D.

Some of the Problems of Electric Train Lighting. George D. Shepardson. A brief review of the application of electricity to train lighting, the various plans and their troubles and cost. 2200 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54777 D.

Discussion of Papers on Railway Train Lighting. General discussion at New York, Pittsburg, Schenectady, St. Louis and other cities. 9300 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54778 D.

Train Lighting Equipments. E. Kilburn Scott. Reviews the papers by Elmer A. Sperry and by Arthur J. Farnsworth. Ill. 1000 w. Elec Rev, Lond—April 10, 1903. No. 54715 A.

MEASUREMENT.

Battery Resistance.

On the Measurement of the Internal Resistance of a Battery. J. H. Oates. Gives two methods which reduce the error caused by the running down of the cell to a minimum, and require no apparatus beyond that found in most laboratories. 1200 w. Elect'n, Lond—April 17, 1903. No. 54948 A.

Dynamometer.

See Mechanical Engineering, Measurement.

Heavy Currents.

Accurate Measurements of Heavy Currents. P. Letheule. On the results obtained in experiments performed under the direction of Prof. Janet. 900 w. Elec Wld & Engr—April 11, 1903. No. 54691.

Iron Losses.

The Determination of the Hysteresis and Eddy-Current Losses in Iron Plates by Means of Wattmeters (Ueber die Wattmetrisabe Bestimmung der Verlustziffer für Eisenbleche). B. Soschinski. A mathematical discussion of methods of measuring these energy losses in iron. 1000 w. Elektrotech Zeitschr—April 16, 1903. No. 54821 B.

Photometry.

A Preliminary Study for a New Standard of Light. J. E. Petavel. An illustrated account of investigations carried out, discussing the requirements of a photometric standard and in what manner

they may be satisfied. 3000 w. Elect'n, Lond—April 10, 1903. No. 54716 A.

See also Gas Works Engineering.

Resonance.

A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms. M. B. Field. Describes experiments made with one of the instruments invented by Mr. Duddell, the high frequency pattern of oscillograph. Ill. 4000 w. Elec Times—March 19, 1903. Serial. 1st part. No. 54410 A.

Rheostat.

A Rheostat for Shunt-Wound Field Coils when Separately Excited (Nebenschlussregulierwiderstände für Fremderregung). Carl Kinzbrunner. An illustrated description of a regulating resistance, placed across the terminals of the source of current, with many contact points to which the magnet coils can be connected, so varying the drop of potential in the latter; this arrangement is particularly useful in getting magnetization curves. 600 w. Elektroteck Zeitschr—March 26, 1903. No. 54812 B.

Field Regulation with Separate Excitation. Carl Kinzbrunner, in the *Elektrotechnische Zeitschrift*. Gives methods of regulating within wide limits. 700 w. Elec Engr, Lond—April 17, 1903. No. 54943 A.

POWER APPLICATIONS.

Alternating Current.

An Unsuccessful Experiment. Fred W. Davis. An account of an unsuccessful alternate-current motor experiment, stating the ideas upon which the experiment was based. 1400 w. Elec Engr, Lond—April 3, 1903. No. 54648 A.

Feed Pumps.

Steam v. Electrically Driven Auxiliary Plant. C. D. Taite and R. S. Downe. Read before the Manchester (Eng.) Section of the Inst. of Elec. Engrs. A comparison, considering the reliability, economy, first cost and up-keep of feed pumps, and also condensing plants. 2500 w. Mech Engr—April 18, 1903. No. 54941 A.

Fire Engine.

A New Electrical Fire Engine. A. Frederick Collins. Describes an engine recently tested at Rouen, France, and proved satisfactory. 800 w. Sci Am—April 18, 1903. No. 54739.

Heyland Motor.

The Heyland Induction Motor (Asynchronmaschinen mit Kurzegeschlossenem Kommutator, ohne in sich Geschlossene Lamellenverbindungen). Alexander Heyland. An illustrated description of a new form of the Heyland induction motor, having a power factor of unity, in which the commutator segments are not permanently shortcircuited. 1000 w. Electrotech Zeitschr—March 19, 1903. No. 54809 B.

Induction Motor Diagrams.

Some Induction Motor Diagrams (Ueber einige Diagramme zum Asynchronen Wechselstrommotor). Hans Görges. A graphical and mathematical discussion of non-synchronous alternating current motors, with diagrams. 3000 w. Elektrotech Zeitschr—April 9, 1903. No. 54817 B.

Load Equalization.

The Equalization of Load Fluctuations in Power Transmission Plants (Ueber Ausgleich von Belastungsschwankungen in Kraftübertragungsanlagen). Gustav Meyersberg. An illustrated paper before the "Elektrotechnischer Verein" on a method of compensating load fluctuations, particularly in electric hoisting plants for mines, by means of an auxiliary dynamo with a high-speed flywheel. Also discussion. 11000 w. Elektrotech Zeitschr—April 2, 1903. No. 54816 B.

Machine Shop.

The Development and Use of the Small Electric Motor. II. The Electric Motor in the Machine Shop. Fred. M. Kimball. This second paper in Mr. Kimball's series deals with the function of electric driving in increasing shop output, lays down the general principles of motor applications to machine tools, and gives valuable figures of the power required for standard tools and operations. Largely illustrated. 4100 w. Engineering Magazine—May, 1903. No. 54852 B.

The Application of Individual Motor Drives to Old Machine Tools. R. V. Wright. A discussion of the points that bear on the problem as to whether it will pay to equip tools now in use with individual motors. 2200 w. Am Engr & R R Jour—April, 1903. Serial. 1st part. No. 54476 C.

Power Test of an Electrically-Driven Shaper. An account of an interesting test made by the Cincinnati Shaper Company. Ill. 800 w. Am Engr & R R Jour—April, 1903. No. 54478 C.

Mine Hoisting.

Electric Winding Engines. E. Kilburn Scott. The present article considers the general aspects of the problem, giving details of the methods of arranging the pulleys or drums, the different types of motors, &c. Ill. 2500 w. Ir & Coal Trds Rev—April 3, 1903. Serial. 1st part. No. 54651 A.

Some Notes on Electrically-Driven Winding Engines An illustrated description of methods employed, with remarks on the advantages of electric driving.

We supply copies of these articles. See page 475.

2000 w. Col Guard—April 17, 1903. No. 54949 A.

Polyphase.

On the Application of Three-Phase Motors to the Electrical Driving of Workshops and Factories. A. C. Eborall. Gives an introductory general discussion, and considers questions relating to the construction and performance of three-phase motors. Illustrations and discussion. 11000 w. Jour Soc of Arts—April 3, 1903. No. 54639 A.

Steering.

Modern Electric Steering Apparatus. Frank C. Perkins. Illustrates and describes various devices. 3000 w. Elec Rev, N Y—March 28, 1903. No. 54436.

Theatre Installation.

See Electrical Engineering, Lighting.

TRANSMISSION.

Insulator Pins.

Mechanical Specifications of a Proposed Standard Insulator Pin. Ralph D. Mershon. Introduction to a discussion of a proposed standard pin covering wooden pins and, so far as it may, metal ones. 1200 w. Trans Am Inst of Elec Engrs—March 27, 1903. No. 54973 D.

Burning of Wooden Pins on High Tension Transmission Lines. C. C. Chesney. Discusses the preparation of the pins, pin troubles and their causes. Ill. 1000 w. Trans Am Inst of Elec Engrs—March 27, 1903. No. 54975 D.

Insulators.

The Testing of Insulators. F. O. Blackwell. Notes and suggestions on the testing of insulators. 1800 w. Trans Am Inst of Elec Engrs—March 27, 1903. No. 54974 D.

Long Distance.

The Electrical Conductivity of the Atmosphere and the Losses Caused Thereby in Long Distance Transmission of Power. Prof. Harris J. Ryan. Abstract of a lecture delivered before the Cornell Chapter of the Sigma Xi. Considers the principles underlying the development of long distance transmission, and discusses the loss in energy due to the breaking down of the atmosphere. Ill. 1800 w. Sib Jour of Engng—April, 1903. No. 54626 C.

Montana.

A High-Voltage Power Transmission. Discussion of the paper by M. H. Gerry, Jr., on the reconstructed plant of the Missouri River Power Co., in Montana. 3800 w. Pro Am Soc of Civ Engrs. April, 1903. No. 54969 E.

The Butte Lighting and Power Company. Illustrates and describes this electric transmission plant. 5000 w. Jour of Elec—April, 1903. No. 54961 C.

Oregon.

The White River—The Dalles Transmission. An illustrated description of the 20,000 volt transmission plant recently completed and of the Knight water wheels with which it is equipped. 3500 w. Jour of Elec—March, 1903. No. 54579 C.

Transformers.

Sheet Steel for Static Transformers. Walter S. Moody. Briefly reviews the development that has resulted in great improvement in the efficiency, safety and life of transformers, and considers the improved structure of the steel used to be the principal reason for the progress made. 1500 w. Elec Wld & Engr—April 11, 1903. No. 54690.

Transformers in Transmission Systems. Alton D. Adams. Gives examples showing the practice and discusses details. 3000 w. Elec Rev, N Y—April 11 and 18, 1903. Serial. Two parts. No. 54671.

Vancouver.

Vancouver Transmission Plant. Wyatt H. Allen. The plant is for the purpose of furnishing light and power for operating the street and interurban railways, and will ultimately have a capacity of 24,000 h. p. The hydraulic arrangements are very unusual, and there are several features of exceptional interest. Also editorial. Ill. 3000 w. Elec Wld & Engr—April 18, 1903. No. 54751.

Victoria Falls.

See Civil Engineering, Canals, Rivers and Harbors.

Wire Sag.

A Determination of the Sag and the Tension in Wires (Zur Bestimmung des Durchhanges und der Spannung in Drähten). H. von Glinski. An approximate analytical and a more exact graphical method for determining the sag and tension in line wires, with diagrams. 1200 w. Elektrotech Zeitschr—April 2, 1903. No. 54815 B.

MISCELLANY.

Agriculture.

Electroculture. Emile Guarini. An examination of the recent experiments of investigators in this field, especially those of M. Sélim Lemstroem. 2200 w. Elec Wld & Engr—April 4, 1903. No. 54667.

Prospecting.

The Daft and Williams Electrical Prospecting System. Illustrated description of prospecting trials made with this system for predetermining the position of mineral ores. 1000 w. Elec Engr, Lond—April 3, 1903. No. 54647 A.

We supply copies of these articles. See page 475.

GAS WORKS ENGINEERING

Benches.

Construction and Operation of Recuperative Benches. W. A. Baehr. Read before the Ohio Gas Lgt. Assn. Considers the principal points in the operation of such benches, and discusses the proper principles of construction. Also general discussion. 9800 w. Pro Age—April 1, 1903. No. 54472.

Calorimetry.

Calorimetry of Gaseous Fuels. W. Garnet Wernham. Read before the Jr. Inst. of Engrs. Reviews the development of the modern form of gaseous fuel calorimeter, illustrating and describing various types. 3000 w. Gas Wld—March 28, 1903. Serial. 1st part. No. 54522 A.

Combination Plant.

A Combination Dellwik Water-Gas and Peebles Oil-Gas Plant at Cleethorpes. An illustrated description of the plant, indicating the various methods of usefulness and giving a statement of results. 3800 w. Jour Gas Lgt. March 24, 1903. No. 54500 A.

Distribution.

Notes on High Pressure Distribution. W. A. Learned. Read at meeting of the New England Assn. of Gas Engrs. States the problem, and describes the system adopted. Ill. Also discussion. 7000 w. Am Gas Lgt Jour—April 6, 1903. No. 54537.

The Development of the Gas Distributing System of the Suburban Gas and Electric Company in Revere and Winthrop, Mass. A. B. Tenney. Read before the N. England Assn. of Gas Engrs. An account of the work, its cost, &c., with discussion. 4500 w. Am Gas Lgt Jour—March 30, 1903. No. 54426.

Gas Producers.

The Thermal Processes in Gas Producers (Die Thermischen Vorgänge in Gaserzeuger). Fritz Lürmann, Jr. An illustrated discussion of the reactions and processes in the manufacture of gas for power purposes. Serial. Two parts. 10,000 w. Stahl u Eisen—April 1 and 15, 1903. No. 54830 each D.

Gas Transmission.

Power Transmission by Gas. Abstract of a paper by Prof. Burstall read at meeting of the Birmingham Sec. of the Inst. of Elec. Engrs. on its possibilities. Also discussion. 5200 w. Gas Wld—April 4, 1903. No. 54641 A.

Mond Process.

The Mond Power-Gas Process. An illustrated description, with statements in regard to the advantages claimed and cost. 3000 w. Jour Gas Lgt—April 14, 1903. No. 54908 A.

Natural Gas.

Natural Gas as a Factor in the Artificial Gas Business. F. W. Stone. Read before the Ohio Gas Lgt. Assn. Considers that it has helped to introduce gas as a fuel, and will eventually prove a help to artificial gas. Discussion. 6700 w. Pro Age—April 1, 1903. No. 54473.

The Central Ohio Natural Gas Fields. J. A. Bownocker. An account of their location and areas, history and development, geology and composition. Map. 4400 w. Am Geol—April, 1903. No. 54471 D.

Petroleum Lighting.

Petroleum Incandescent Lighting. Arthur Kitson. Illustrated detailed description of a petroleum incandescent plant, and account of some of the difficulties met in perfecting the system. Describes the methods of ignition. Discussion follows. 8500 w. Jour Soc of Arts—March 27, 1903. No. 54528 A.

Photometry.

A Development in Photometry. Brief account of a new instrument which seems to overcome all obstacles in the problem of the measurement of differently colored lights. 1600 w. Gas Wld—April 18, 1903. No. 54906 A.

Plant Operation.

The Operation of a Gas Works. W. A. Baehr. Gives an outline of processes employed to-day in gas plants. 3200 w. Wis Engr—Feb., 1903. No. 54607 D.

Power.

Cheap Gas for Motive Power. J. H. Brearley. Discusses prices and competition, and refers to paper by A. B. Mountain, extracts being given. 2500 w. Gas Wld—April 11, 1903. No. 54713 A.

Power Production by Gas Producers and Engines. Robert W. A. Brewer. Read before the Civ. & Mech. Engrs. Soc. Considers the advantages of a producer, the best types, blast furnace gas and large gas engines in the present article. Ill. 4800 w. Mech Engr—April 4, 1903. Serial. 1st part. No. 54644 A.

Producer Gas and Gas Engines. An explanation of how a gas producer is con-

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structed and operates, showing its economy. 3500 w. Power—April, 1903. No. 54433 C.

Gas for Industrial Purposes. James H. Walker. Read at meeting of the Wisconsin Gas Inst. Information relating to the experience of the Milwaukee Gas Light Co. in the introduction of gas for industrial uses, and the methods which were successful. Illustrates appliances. 2000 w. Am Gas Lgt Jour—March 30, 1903. No. 54427.

Retort Charging.

A Visit to M. de Brouwer at Bruges. An account of the retort-charging apparatus and its operation, with illustrations. 5700 w. Jour Gas Lgt—March 24, 1903 Serial. 1st part. No. 54499 A.

Retorts.

A Proposed New System of Building Retort-Houses. The first of a series of articles, mainly introductory, setting forth the merit and advantages of reinforced concrete construction. 2200 w. Jour Gas Lgt—April 7, 1903. Serial. 1st part. No. 54649 A.

Separator.

The Mazza Separator. Translated from *Il Gaz.* An account of a simple machine and the successful experiments made. 1000 w. Gas Wld—April 18, 1903. No. 54907 A.

Street Lighting.

A Defense of the High Prices of Street Lighting in New York, and a Reply thereto. Reviews the statement made by John M. Bowers, on behalf of the Consolidated Gas Co., and the reply by Robert Grier Monroe. 1800 w. Eng News—April 23, 1903. No. 54919.

INDUSTRIAL ECONOMY

American Workmen.

Labor Conditions in America (Amerikanische Arbeitsverhältnisse). Georg Dinglinger. An interesting discussion of factory and wage systems, the character of workmen and labor conditions in general in America, by a German who worked in American shops to study conditions there. Serial. Two parts. 7500 w. Glasers Annalen—April 1 and 15, 1903. No. 54825 each D.

Coal Strike Report.

The Award of the Anthracite Coal Strike Commission. Walter E. Weyl. A review of the work of the commission and matters related. 4500 w. Rev of Revs—April, 1903. No. 54468 C.

Report of the Coal Strike Commission. Reviews the work of the Anthracite Coal Strike Commission and its findings. 3500 w. Gunton's Mag—May. 1903. No. 54965.

Competition.

American Competition with Britain, from a Canadian Point of View. A discussion of trade conditions and the contrast between English and American methods. 4500 w. Engng—April 3, 1903. No. 54656 A.

Conciliation.

The Harmonizing of Organized Labor with Organized Capital. M. Cokely. An argument for the policy of conference, conciliation, and mutual fairness, even at the expense of the exercise of considerable self-restraint. Organization, both of capital and labor, is shown to be not only contributory but essential to the settlement of the problems. 3000 w. Engineering Magazine—May, 1903 No. 54851 B.

Industrial Progress.

Modern Industrial Progress a Social Problem. Carroll D. Wright. Extracts from an address before the National Assn. of Mfrs., at New Orleans, La. 3700 w. Ir Age—April 30, 1903. No. 54982.

Inventors.

The Inventor and the Trust. William Stanley. Reprinted from the *Springfield Republican.* Thinks the present methods adopted by the trusts, if uncontrolled, will stifle invention and retard progress. 2300 w. Elec Wld & Engr—March 28, 1903. No. 54449.

Title to Inventions and Patents by Employees. Gives a form of agreement being used by a large engineering establishment, with editorial comment. 1400 w. Am Mach—April 2, 1903. No. 54480.

Labor.

Labor's Complaint Against Capital. Frederic Hay. A short presentation of the conditions now existing, as they appear to the employee, with the employee's view of the necessary remedies. 1300 w. Engineering Magazine—May, 1903. No. 54858 B.

Political Economy and the Labor Question. J. H. Hollander. A discussion of the wage-fund theory, and the value of the political economist in solving the labor question. 3000 w. N Am Rev—April, 1903. No. 54457 D.

Labor Unions.

The Attitude of Employers Toward

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Labor Unions. Extracts from an address by John Kirby, Jr., before the Nat. Assn. of Mfrs., at New Orleans. Urges the thorough organization of employers, and the protection of the wage-earner in the right to sell his labor to whom he pleases and for the price he pleases. 3200 w. Ir Age—April 23, 1903. No. 54763.

Merger Decision.

The Merger Decision. Discusses the decision in the case of the United States against the Northern Securities Company, arguing that the Sherman act should be repealed, and that its enforcement would disorganize industry. 1200 w. Gunton's Mag—May, 1903. No. 54964.

Mine Accounting.

A Practical System of Mine Accounting. E. Jacobs. The methods of the Le Roi, B. C., Mines, with reproduction of all the forms, blanks, book rulings, and record sheets. 3000 w. Engineering Magazine—May, 1903. No. 54853 B.

Mosely Commission.

The Mosely Industrial Commission Reports. Reviews the reports made by a commission representing the principal industries of Great Britain of the tour to investigate the industrial situation jn the United States. 5000 w. Ir Age—April 30, 1903. No. 54983.

Municipal Trading.

Does Municipal Trading Pay? Hon. Robert P. Porter. A discussion of the advantages and disadvantages, reviewing the history of such undertakings in various countries, and especially discussing British affairs. 5000 w. Trac & Trans—April, 1903. No. 54903 E.

Premium Plan.

Cost Reduction by the Use of the Premium Plan. C. A. Colwell. A very interesting account of five months' practical experience in a large shop, describing the policy followed, the results secured, and the formulas established for standard operations. Gives some very interesting data of cost reduction by the use of the new tool steels. Illustrated. 4000 w. Engineering Magazine—May, 1903. No. 54856 B.

A Premium System Applied to Engineering Workshops. James Rowan. Gives facts gained in an experience of five-years' working of the system. 4500 w. Inst of Mech Engrs—March 20, 1903. No. 54505 D.

The Premium System of Remunerating Labor. John Ashford. Read before the Manchester (Eng.) Assn. of Engrs. Explains the principle of this system and the features that have developed in its working. 3400 w. Mech Engr—April 18, 1903. Serial. 1st part. No. 54940 A.

A Modification of the Premium Plan. W. H. Booth. A discussion of methods of adjusting rates, with editorial criticism. 1800 w. Am Mach—April 16, 1903. No. 54700.

Shipping Subsidies.

Shipping and Subsidies. Benjamin Taylor. A discussion of the conditions of British and American shipping, and denial of statements made in articles by Charles H. Cramp. 6200 w. N Am Rev—April, 1903. No. 54456 D.

Shop Records.

A Work in Progress Record. Horace L. Arnold. Describes two forms in use in the Cottrell works for historical records of events. 2200 w. Am Mach—April 23, 1903. No. 54782.

Simplon Tunnel.

See Civil Engineering, Construction.

Waterbury Injunction.

The Waterbury Injunction. A discussion of the injunction issued by Judge Elmer against the strikers and their sympathizers in Waterbury, Conn. 2000 w. Gunton's Mag—April, 1903. No. 54469.

MARINE AND NAVAL ENGINEERING

Armor-Clads.

Results of a Naval Inquiry as to Which is the Most Powerful Armor-Clad Afloat. Translated from the French of J. Delaporte, in *L'Illustration*. Determines the best armor-clad in each navy, then compares the types. Ill. 3500 w. Sci Am Sup—April 18, 1903. No. 54741.

Ballasting.

The Ballasting of Steamers. S. J. P. Thearle. Read before the Inst. of Nav. Archts. States some of the experiences which show the importance and necessity of ballasting, and considers methods which have been adopted. Ill. 4500 w. Engng—April 17, 1903. No. 54957 A.

Battleship Engines.

See Mechanical Engineering, Steam Engineering.

Battleship.

The Italian First-Class Battleship. Benedetto Brin. Illustrations, tabulated particulars and comparisons, with descriptive notes. 1500 w. Engr, Lond—April 17, 1903. No. 54953 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

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Cedric.

New White Star Line Steamship Cedric. A fully illustrated article describing in detail the interesting features of this new vessel. 1500 w. Marine Engng—April, 1903. No. 54492 C.

Compass.

Importance of a Correct Ship's Compass. Lieut. W. H. Faust. Reprinted from 1903 edition of Ship-Masters' directory. On compensating or adjusting the compass; deviations and their causes. 3000 w. Marine Rev—April 23, 1903. No. 54779.

Corrosion.

Corrosion in Metal Pipes on Board Ship. A. W. Stewart. Abstract of a paper before the Inst. of Nav. Archts. Gives details of investigations made by the writer on behalf of the Russian Volunteer Fleet, with the object of ascertaining if the dynamos on board were responsible for the very rapid deterioration taking place in some of the pipes. 2400 w. Engr, Lond—April 10, 1903. No. 54725 A.

Cruisers.

On the "Lines" of Fast Cruisers. C. C. P. Fitz Gerald. Read before the Inst. of Naval Archts. A discussion of this subject, with some comparisons. Ill. 1500 w. Engng—April 3, 1903. No. 54660 A.

The Argentine Cruiser "Moreno." Illustrated description of a vessel of the Garibaldi class recently launched. 800 w. Engng—April 10, 1903. No. 54727 A.

Engineers' Training.

The Training of Engineers in the United States. Prof. W. E. Dalby. Read before the Inst. of Naval Archts. A statement of facts obtained during a recent visit. 5000 w. Engng—April 10, 1903. No. 54731 A.

Floating Docks.

Barcelona Depositing Dock. Two-page plate and brief description of a floating dock of the single-sided type, attached by hinged booms to a floating outrigger. Describes the method of depositing. 800 w. Engng—March 27, 1903. No. 54513 A.

King's Lynn.

Screw Steamer for Towing, Salvage, and Fire Purposes. Illustrated detailed description of a substantial single-screw vessel built for the King's Lynn Conservancy Board, Eng. 2-page plate. 1000 w. Engng—April 17, 1903. No. 54955 A.

Lighthouse.

The New Beachy Head Lighthouse. T. Williams. Illustrates and describes the construction of the new Beachy Head lighthouse, on the English coast. 2500 w. Feilden's Mag—April, 1903. No. 54742 B.

See also Electrical Engineering, Lighting.

Merchant Marine.

The Future of Our Merchant Marine. Edwin Maxey. A discussion of the prospects of the United States as ship-builder and ship-owner. 2500 w. Gunton's Mag—May, 1903. No. 54966.

Minnesota.

The New American-Built Liner "Minnesota." Illustration, with description, of this mammoth freight and passenger steamship which will be used in the Pacific trade. 1000 w. Sci Am—April 18, 1903. No. 54738.

Paddle vs. Screw.

The Paddle vs. the Screw. From the Charleston, W. Va., *Daily Gazette*. An account of an interesting power test between new and old style steamers on the Kanawha river. Ill. 2000 w. Naut Gaz—April 2, 1903. No. 54487.

Petrol Motors.

See Mechanical Engineering, Special Motors.

Propellers.

The Screw as a Means of Propulsion for Shallow-Draught Vessels. A. F. Yarrow. Read before the Inst. of Nav. Archts. Describes and illustrates a set of experiments carried out to test the towing efficiency of the screw working in a tunnel. 2500 w. Engng—April 10, 1903. No. 54730 A.

Propellers and Rudders.

Efficiency of Propellers and Rudders. George H. Wilson. Discusses the changes in the location of the rudder and the altered position of the propellers proposed by some authorities, aiming to effect an improvement in the steering qualities and to increase the propulsive coefficient. 2700 w. Marine Engng—April, 1903. No. 54496 C.

Railroad Ferries.

Danish Government Railroad Ferries. William Kolvig. An illustrated article giving information in regard to these ferries which furnish a connection between the islands and mainland. 700 w. R R Gaz—April 24, 1903. No. 54922.

Resistance.

Further Notes on the Influence of Shoal-Water Upon the Speed of Ships. Alfred E. Luders. Calls attention to experiments which bear out, more or less, the conclusions to be formed from a study of Captain Rasamussen's investigations. 1500 w. Marine Engng—April, 1903. No. 54498 C.

School Ship.

The Nautical Preparatory School and the Ship Young America. Illustrates

and describes a ship that will take young men and prepare them, while afloat, for business or college life, giving schooling, practical training and world-wide travel. 2800 w. Marine Engng—April, 1903. No. 54495 C.

The Young America. Illustration, with description, of a vessel to carry a floating school, which is under construction. Not a school ship in the usual acceptance of the term, but to carry students being prepared for business or for college, enabling them to see the world at the same time. 1400 w. Engr, Lond—March 20, 1903. No. 54406 A.

Submarine.

An Under-Water Automobile. Herbert C. Fyfe. An illustrated account of the new American submarine torpedo-boat "Protector," discussing its efficiency as compared with the Holland type. 3000 w. Page's Mag—April, 1903. No. 54754 B.

Warships.

Modern Warships. W. H. Whiting. Read before the Inst. of Naval Archts. On the effect of features introduced during the last twenty years, which are not necessary to the main object of a warship, on the size and cost of these vessels. 5200 w. Engng—April 3, 1903. No. 54659 A.

Yachts.

Launch of the "Reliance." Illustrations, with description of the striking features. 800 w. Sci Am—April 25, 1903. No. 54910.

MECHANICAL ENGINEERING

AUTOMOBILES.

Agriculture.

Motors in Agriculture. The first of a series of illustrated articles showing the applications made of motors. The present article deals with steam cultivation. 800 w. Sci Am Sup—April 11, 1903. Serial. 1st part. No. 54668.

Construction.

Influence of Carriage Styles on the Construction of Automobiles. Marcus C. Kramp. A discussion of types and development in automobile design, with illustrations. 4700 w. Automobile—April 11, 1903. No. 54675.

Marching Toward Simplicity in Automobile Construction. A. R. Sennett. Extracts from an address to the Roy. Auto. Clubs of Gt. Brit. and Ireland. Calling attention to the evolution which has taken place. 2500 w. Automobile—April 4, 1903. No. 54531.

Electric Vehicles.

Electric Pleasure Vehicles for All Purposes and Purses. Describes the ideal pleasure carriage, its construction and operation, giving points about the storage battery and illustrating styles of vehicles on the market and range of prices. 4000 w. Automobile—March 28, 1903. No. 54425.

Exhibition.

The Annual Agricultural Hall Exhibition. A report of this exhibition at Islington, with illustrated descriptions of exhibits. 3200 w. Auto Jour—March 28, 1903. Serial. 1st part. No. 54525 A.

India-Rubber.

India-Rubber. Mervyn O'Gorman. Some facts about this substance that motorists should know. 2000 w. Autocar—April 18, 1903. No. 54905 A.

Induction Coils.

The Induction Coil Explained. An explanation of the principles and construction. 1700 w. Autocar—March 28, 1903. Serial. 1st part. No. 54526 A.

Motor Carriers.

Motor Carriers for Small Crops. G. Lacy Hillier. The advantages of these vehicles for handling small crops and supplies are discussed. 2000 w. Autocar—April 11, 1903. No. 54711 A.

Motor Cycle.

An Expert's View of the Motor Cycle. Discusses the advantages and disadvantages, with conclusions in its favor. 2000 w. Automobile—April 11, 1903. No. 54676.

Motor-Vans.

Motor-Vans for Railway Companies. Brief illustrated descriptions of vehicles designed to replace horse-drawn vans for goods collection and delivery. 2000 w. Transport—April 3, 1903. No. 54638 A.

Omnibuses.

Steam Omnibuses at Westerly, U. S. A. Hugh Dolnar. Brief illustrated description of vehicles put in service for passenger transportation, and package delivery. 1500 w. Autocar—April 11, 1903. No. 54710 A.

Petrol Cars.

Hints on Driving Petrol Cars. General remarks on the handling of these vehicles. 1600 w. Motor Car Jour—April 18, 1903. No. 54937 A.

Petrol Cars. An illustrated review of

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the petrol cars shown at the exhibition in Islington. 7500 w. Autocar—March 28, 1903. No. 54527 A.

The Chenard and Walcker 14 H. P. Petrol Car. An illustrated detailed description. 2200 w. Auto Jour—April 11, 1903. No. 54712 A.

The Dietrich-Bugatte Petrol Cars. Illustrates a partly finished 24 H. P. chassis and the engine in position. Also gives a side elevation and plan of the car. Chiefly interesting because of the peculiar construction of the engine. 700 w. Auto Jour—April 18, 1903. No. 54936 A.

The "Soames" Petrol Car. Full illustrated description of this car. 1500 w. Auto Jour—March 28, 1903. Serial. 1st part. No. 54524 A.

Steam Cars.

The Chaboche Steam Cars. An illustrated detailed description of the system and mechanism. 1800 w. Auto Jour—March 28, 1903. Serial. 1st part. No. 54523 A.

Steam Engine.

Simple Form of Steam Engine for Self-Propelled Commercial Vehicles. Walter L. Bodman. An illustrated detailed description of the Simpson D. Bodman's three-cylinder vertical engine for superheated steam. 3000 w. Automobile—April 25, 1903. No. 54781.

Trucks.

A Novelty in Steam Trucks. Illustrates and describes a propelling mechanism which is intended to be applied to ordinary horse-drawn trucks. 1800 w. Automobile—March 28, 1903. No. 54424.

HYDRAULICS.

Plumbing.

Water Supply and Distribution in the Corn Exchange Bank Building, New York. Describes the general arrangement, giving details of pumps, tanks and drains. Ill. 1200 w. Eng Rec—April 4, 1903. No. 54561.

Pumping Station.

A Sewage Pumping Station at Santiago, Cuba. Brief illustrated description of the plant. 1200 w. Eng Rec—April 25, 1903. No. 54792.

Water-Wheels.

Tangential Water-Wheels. An illustrated article describing these wheels and their development. 3500 w. Engng—March 27, 1903. No. 54509 A.

MACHINE WORKS AND FOUNDRIES.

American Turret Lathe.

New Works of the American Turret Lathe Mfg. Company. Gives an illustrated detailed description of the works, stating the considerations that were given prominence in their design. 1800 w. Ir Age—April 30, 1903. No. 54981.

Backing-Off Attachment.

Backing-Off Attachment for the Lathe. William Runge. Illustrated description of an attachment intended for relieving or backing off the teeth of formed cutters, hobs, taps, etc., and is fitted to a lathe having a taper turning attachment. 700 w. Am Mach—April 23, 1903. No. 54785.

Brass Furnace.

A Home-Made Brass Furnace. Millard F. Smith. Brief illustrated description. 600 w. Foundry—April, 1903. No. 54601.

Cams.

See Mechanical Engineering, Power and Transmission.

Castings.

Foundry Accounting and Methods of Estimating Cost of Castings. O. C. Barrows. Read at meeting of the N. Eng. Found. Assn. Describes a method that has proved satisfactory. 3500 w. Ir Trd Rev—April 16, 1903. No. 54732.

Strength of White-Iron Castings as Influenced by Heat Treatment. A. E. Outerbridge, Jr. Read at meeting of the Am. Soc. of Testing Materials, June, 1902. Gives a résumé of the history of the process of heat-treatment of white-iron castings, and states facts regarding tensile strength and other features of interest. 3800 w. Jour Fr Inst—April, 1903. No. 54460 D.

Countershafts.

Strength of Countershafts. Frank B. Kleinhans. Discusses the causes of accidents from countershafts, principally the failures due to the shaft being too long between hangers. 1000 w. Mach, N Y—April, 1903. No. 54474 C.

Dies.

Die for Piercing Brass Shells. Illustrates and describes a die for punching three holes in the side of a drawn brass shell. 1000 w. Am Mach—April 2, 1903. No. 54452.

Electric Driving.

See Electrical Engineering, Power Applications.

Feed.

Automatic Feed for Embossing Press. Illustrates and describes an automatic rack feed and its operation. 1200 w. Am Mach—April 23, 1903. No. 54783.

Foundry.

The Advantages of Having a Foundry Attached to an Existing Engineering Works in the Country. J. A. Coombs. Shows the effect in cost of castings and considers the subject generally. 1800 w. Prac Engr—April 3, 1903. No. 54642 A.

Foundry Management.

Foundry Management in the New Century. VI. The Dressing of Castings. Robert Buchanan. Reviews the methods and apparatus used in cleaning castings by tumbling, sand blast, abrasive wheels, and pneumatic tools, with the comparative merits, cost, and effectiveness of each. Illustrated. 3500 w. Engineering Magazine—May, 1903. No. 54855 B.

Rigs as a Factor in Foundry Management. Edward Kirk. An article discussing the advantage of proper rigging. 1600 w. Foundry—April, 1903. No. 54603.

General Electric.

The Plant and Operations of the General Electric Company, Ltd., at Witton. An illustrated descriptive account. 1800 w. Ir & Coal Trds Rev—April 17, 1903. No. 54958 A.

Grinding.

The Grinding Machine and Its Possibilities. H. Darbyshire. Based on experience gained in the workshops of Alfred Herbert, Limited, in Coventry, England. Discusses important points in grinding. 5500 w. Engr, Lond—March 20, 1903. No. 54407 A.

The Grinding Machine and Some Tools. H. Darbyshire. The first of a series of articles discussing the work done by grinding machines, and describing experiments made with surface grinding machines. 3500 w. Engr, Lond—March 27, 1903. Serial. 1st part. No. 54501 A.

Lathe.

A Large Turret Lathe. Drawings of the principal parts of an exceptionally large flat turret lathe, with descriptive notes. 900 w. Engr, Lond—April 3, 1903. No. 54663 A.

Lathe Apron.

Engine Lathe Apron. Illustrated description of the apron with which the lathes of the Draper Machine Tool Co. are fitted. 700 w. Am Mach—April 9, 1903. No. 54584.

Milling Machines.

Some Features of a Milling Machine Shop. An account of a shop in Milwaukee, and some of the things seen there. Ill. 1800 w. Am Mach—April 2, 1903. No. 54451.

The New Le Blond Milling Machine. Illustrated description of these machines, calling attention to some features which are of interest. 1300 w. Ir Age—April 2, 1903. No. 54450.

Patterns.

Making a Herring-Bone Pinion Pattern. G. F. Dodge. Illustrates and describes the method used. 500 w. Am Mach—April 23, 1903. No. 54784.

Pneumatic Tools.

Pneumatic Tools and Appliances. Ewart C. Amos. Abstract of a paper before the Manchester Assn. of Engrs. Considers hammers and riveters, drilling machines, screen shaker, rock drill, etc. Ill. 2500 w. Mech Engr—March 21, 1903. No. 54414 A.

Pressed Axles.

A New Method of Making Railway Axles (Eine Neu Herstellung von Eisenbahnachsen). Prof. Reuleaux. An illustrated paper before the "Verein für Eisenbahnkunde" in Camille Mercader's method of forming steel axles by punching a heated bar axially and forcing the metal into a die. With discussion. 2000 w. Glasers Annalen—April 1, 1903. No. 54824 D.

Rolling Mills.

Measuring the Power Required for Street Rolling Mills. H. G. Manning. Gives a power chart used by the writer, and explains its use. 700 w. Eng News—April 23, 1903. No. 54918.

Rolls.

Chill Rolls. R. E. V. Luty. Considers some of the problems of their manufacture and use. 4000 w. Ir Age—April 23, 1903. Serial. 1st part. No. 54761.

Tools.

Labor-Saving Tools at the Baltimore Repair Shops. Illustrates and describes some of the especially designed tools for work in these shops. 3000 w. St Ry Jour—April 4, 1903. No. 54562 D.

Welding.

Welding in Place the Broken Rudder-Post of a 9000-Ton Screw Steamer. Robert Grimshaw. Brief illustrated description of the welding in place by use of "thermit." 500 w. Am Mach—April 9, 1903. No. 54586.

See also Electrical Engineering, Miscellany.

MATERIALS OF CONSTRUCTION.

Axle Steel.

A Study of the Relations Between the Microstructure, the Heat Treatment, and the Physical Properties of Axle Steel. Henry Fay, A. W. Higgins, and F. W. Coburn. Reviews the work of other investigators, and describes tests made by the authors, discussing the results. Ill. 3000 w. Tech Quar—March, 1903. No. 54595 E.

Brass.

The Production of a Black Color on Brass. Erwin S. Sperry, in the *Metal Industry*. Describes the solution and method generally employed. 900 w. Ir Age—April 16, 1903. No. 54673.

We supply copies of these articles. See page 475.

Fracture.

The Fracture of Metals Under Repeated Alternations of Stress. J. A. Ewing and J. C. W. Humfrey. From the *Philosophical Transactions* of the Royal Soc. of London. Describes experiments in which the microscope has been applied to study the nature of the process of fatigue by which breakdown occurs under repeated reversals of stress. Ill. 3500 w. Metallographist — April, 1903. No. 54610 F.

MEASUREMENT.

Belting Chart.

Belting and Pulley Chart. A. G. Holman. Gives the chart and rules explaining its use. 1200 w. Power—April, 1903. No. 54431 C.

Dynamometer.

Design for a 15-Horse-Power Brake Dynamometer. Nathaniel R. Craighill. Working drawings and description of a friction brake intended for use in testing electric motors, gas engines, or other machines, the capacity of which does not exceed 15 h.-p. 1800 w. Am Elect'n —April, 1903. No. 54484.

Recording Instruments.

Observing and Recording Rapidly Varying Periodical Phenomena (Sur l'Observation et l'Enregistrement de Phénomènes Périodiquement et Rapidement Variables). E. Hospitalier. An illustrated paper discussing modern methods and devices for observing and recording phenomena in engineering work, with special reference to rapid and periodical variations. 7500 w. Mem Soc Ing Civils de France—Feb., 1903. No. 54840 G.

Slide-Rule.

The Hazen-Williams Hydraulic Slide Rule. Describes the method of using this slide-rule, for computing the flow of water in pipes and channels. 2800 w. Eng Rec—March 28, 1903. No. 54446.

Test Pieces.

The Influence of Variations in the Section of Test Pieces upon the Results of Tensile Tests (Der Einfluss von Ungleichmässigkeiten im Querschnitte des Prismatischen Teiles eines Probestabes auf die Ergebnisse der Zugprüfung). Hr. Diegel. A discussion, with diagrams and tables, of the different results of different tests for elongation and tensile strength caused by turning down the central part of the test piece. 700 w. Zeitschr d Ver Deutscher Ing—March 21, 1903. No. 54802 D.

Wire Sag.

See Electrical Engineering, Transmission.

POWER AND TRANSMISSION.

Air Compression.

Air Compression by Water Power. The Installation at the Belmont Gold Mine. D. G. Kerr. Brief illustrated description of this plant, with reasons for its choice in preference to electricity. 2400 w. Can Min Rev—March 31, 1903. No. 54533 B.

Air Compressor.

A Compound Air Compressor with Hoerbiger Valves (Verbundkompressor mit Lenkerventilen, Bauart Hoerbiger). L. Walther. An illustrated description of an air compressor fitted with linked plate valves on the Hoerbiger system, built by the Dingler Machine Works in Zweibrücken. Indicator diagrams. 1 plate. 1500 w. Zeitschr d Ver Deutscher Ing—April 4, 1903. No. 54805 D.

Belts.

The Slip of Belts. J. Stormonth. A consideration of this subject, showing how slip or creep takes place, and the benefit of pulleys, large in diameter, for belt driving. 2700 w. Engr, Lond—April 3, 1903. No. 54664 A.

Cam.

Theory of the Stamp Battery Cam. R. W. Chapman. A study of the geometry of the problem. 2000 w. Aust Min Stand—March 5, 1903. No. 54719 B.

Compressed Air.

Transmission of Power by Compressed Air. W. C. Popplewell. Considers the uses to which it can be applied, its economy, objections to its use, and related matters. 4000 w Mech Engr—April 18, 1903. No. 54939 A.

Elevators.

Vertical Transportation. A brief review of the progress made in elevator development, and the types in use. 1300 w. Sci Am—April 4 1903. No. 54488.

Fans.

Designing and Testing Centrifugal Fans. William Gilbert. The paper is supplementary, to a certain extent, to one read by Mr. Heenan in 1895, which dealt chiefly with small fans. The present paper deals with fans of larger size, giving also particulars of tests. Ill. 1400 w. Mech Engr—April 18, 1903. Serial. 1st part. No. 54938 A.

Flywheels.

Weight of Flywheels for Engines Driving Direct Connected Alternators. A. M. Levin. Derives a formula from well-established theory, supplemented by a few approximations, which conform to a number of carefully plotted displacement curves. 1500 w. Am Mach—April 23, 1903. No. 54786.

Tightening Pulley.

The Leneven Tightening Pulley for Belting (Rapport sur le Système de Commande Breveté par le Galet Enrouleur Débrayeur de M. le Capitaine Leneveu). G. Richard. An illustrated description of a balanced tightening pulley which is close to the driven pulley and increases the arc of contact of the belt up to 300 degrees. 700 w. Bull Soc d'Encouragement—March 31, 1903. No. 54845 G.

Variable-Speed Gear.

A Variable-Speed Gear for Bicycles (Rapport sur le Changement de Vitesse pour Bicyclette). M. Diligeon. An illustrated description of J. M. Roullot's change-speed gear for bicycles, in which different sized spur gears on the crank axle are made to engage with teeth on the interior of the sprocket wheel. 600 w. Bull Soc d'Encouragement—March 31, 1903. No. 54844 G.

Worm Gearing.

Test of a Triple-Thread Worm Gear Transmission (Untersuchung eines Dreigängigen Schneckengetriebes). A. Baumann. A discussion of the paper of the same title by C. Bach and E. Roser, and a graphical representation, in three dimensions, of the relations between efficiency, tooth pressure and temperature and efficiency, tooth pressure and sliding speed. 400 w. Zeitschr d Ver Deutscher Ing—April 11, 1903. No. 54808 D.

SPECIAL MOTORS.

Alcohol Motors.

Alcohol Motors at the International Competition of 1902 (Les Moteurs à Alcool au Concours International de 1902). Max Ringelmann. Data and results of tests made at the experimental station of the exhibition of 1902, at Paris, with illustrations of stationary and portable alcohol motors, and curves and tables showing their performance. 10000 w. Revue de Mécanique—March 31, 1903. No. 54841 E + F.

Tests of Alcohol Motors and Diesel Motors (Versuche an Spiritusmotoren und am Diesel-Motor). Eugen Meyer. A long, comprehensive article, with diagrams and tables, giving an account of tests of alcohol portable engines, under the auspices of the German Agricultural Society, and of Diesel motors. Serial. Part 1. 6000 w. Zeitschr d Ver Deutscher Ing—April 11, 1903. No. 54807 D.

Banki Motor.

The Banki Motor. C. A. Dawley. Gives results of a test of a motor of this type, made by Profs. Jonas and Taborsky on an engine rated at 20 H. P. 2000 w. Sib Jour of Engng—April, 1903. No. 54628 C.

Diesel.

The Diesel Engine. Gives an illustrated description of the latest type of this engine, calling attention to its distinctive characteristics. 1600 w. Power—April, 1903. No. 54429 C.

Gas Engines.

See Electrical Engineering, Generating Stations. Also Gas Works Engineering.

Gas Turbine.

Theory of the Gas Turbine. Sanford A. Moss. Advance portion of a thesis to be presented to the Faculty of Cornell University for the degree of Ph. D. 3500 w. Engr, U S A—April 15, 1903. No. 54746 C.

Ignition.

Electric Ignition in Gas Motors. Sir David Salomons. Considers the various modes of electric ignition and the precautions which ought to be taken to prevent accidents. 3300 w. Elec Rev, Lond—March 27, 1903. Serial. 1st part. No. 54518 A.

Petrol Motors.

Marine Perol Motors at the Boating Exhibition, Earl's Court, London. Brief illustrated descriptions of some of the more important exhibits. 3000 w. Engrs' Gaz—April, 1903. No. 54634 A.

STEAM ENGINEERING.

Adiabatic Expansion.

Curves Representing Adiabatic Expansion of Steam. F. Foster. Uses the entropy diagram to determine the value for various initial conditions of pressure and dryness. 1200 w. Engr, Lond—April 10, 1903. No. 54720 A.

Battleship Engines.

Triple-Expansion Twin-Screw Propelling Engines of the U. S. Battleships Connecticut and Louisiana. Illustrated description of the engines which will be right and left hand, placed in water-tight compartments, separated by a middle-line bulkhead. 1200 w. Marine Engng—April, 1903. No. 54497 C.

Berlin Store.

See Electrical Engineering, Generating Stations.

Boiler Economy.

The Boiler Furnace and Its Relation to the Fuel. Robert S. Hale. Considers the furnace and the grate in the present article, showing how some of the methods for improving them may result injuriously to the economy of the boiler. States the principles involved in attaining good economy and discusses their application as the grades of coal used in the boiler furnace differ. 5400 w. Engr, U S A—April 1, 1903. No. 54571 C.

We supply copies of these articles. See page 475.

Boilers.

Some Miscellaneous Types of Marine Boilers. William H. Fowler. The present article illustrates and describes the multitubular boiler with oval shell. 800 w. Mech Engr—March 28, 1903. Serial. 1st part. No. 54530 A.

Combustion.

Chemistry of Combustion. John C. Olsen. Describes the changes during the burning of different fuels and the causes of the variation in calorific power. 2000 w. Engr, U S A—April 1, 1903. No. 54565 C.

Burning of Fuel Under Pressure. Charles E. Lucke. Considers the means of obtaining good combustion. 1200 w. Engr, U S A—April 1, 1903. No. 54577 C.

Compression.

Compression in Steam-Engine Cylinders. C. L. Browne. An examination of the experiments showing losses with high compression, comparing these with the better results obtained in actual practice with modern large engines. 3500 w. Elec Engr. Lond—March 27, 1903. No. 54521 A.

Condensers.

Condensers and Cooling Towers. Charles L. Hubbard. The first of a series of articles showing the gain in power and economy by condensing operation. 2800 w. Steam Engng—April 10, 1903. Serial. 1st part. No. 54631.

The Ljungström Condenser as Applied to Marine Engines. William Cross. Abstract of a paper read before the Inst. of Naval Archts. Brief illustrated description. 800 w. Engr, Lond—April 3, 1903. No. 54665 A.

Fuels.

Bagasse as a Fuel and the Furnaces Used to Burn It. Samuel Vickers. Explains the term, and gives brief illustrated descriptions of furnaces for burning it, and information regarding its calorific value. 3200 w. Engr, U S A—April 1, 1903. No. 54576 C.

Coke as a Fuel. George L. Fowler. Considers it only in its application to steam making, and regards it as an almost ideal fuel for locomotive or stationary work, its use being merely a matter of price and supply. 1700 w. Engr, U S A—April 1, 1903. No. 54572 C.

The Determination of the Heating Value of Fuel. Herman Poole. Gives brief accounts of some of the leading methods used to determine the heating value of fuels. 2800 w. Engr, U S A—April 1, 1903. No. 54566 C.

The Value of Tar as Fuel. Charles F. Prichard. Gives facts relating to methods of burning, calorific power, and value. 1500 w. Engr, U S A—April 1, 1903. No. 54573 C.

Furnace Crowns.

Gradual Collapses of Furnace Crowns. A Suggested Explanation. H. M. Roundthwaite. Read before the Inst. of Naval Archts. Describes the stresses and their tendency. 1500 w. Mech Engr—April 11, 1903. No. 54714 A.

Governors.

Hints on the Design and Construction of Shaft Governors. C. B. Risley. Discusses points affecting regulation and durability. Ill. 1200 w. Power—April, 1903. No. 54432 C.

Liquid Fuel.

Liquid Fuel or Power Purposes. Arthur L. Williston. A valuable synopsis of the mechanical aspects of the question, based on the successful experience of some very large users of fuel oil. Gives diagrams of burners and furnaces for stationary and locomotive practice. Illustrated. 4000 w. Engineering Magazine—May, 1903. No. 54857 B.

Crude Oil as Fuel. A. M. Hunt. Condensed paper, read before the California Miners' Assn. Concerning oil-burning plants, burners, cost, etc. 2800 w. Min & Sci Pr—April 11, 1903. No. 54735.

Fuel-Oil and Oil Burners for Steam Boilers. William Kent. Gives some of the advantages of oil as a fuel, and an experimental study of its heating value, and the right way to burn it. Illustrates numerous types of burners. 2700 w. Engr, U S A—April 1, 1903. No. 54567 C.

Oil Burning at Pratt Institute. Joseph Foster. An illustrated description of the method used, reporting that to reach an economy equal to coal, oil would have to be bought for 2 cts. a gallon. 1800 w. Engr, U S A—April 1, 1903. No. 54578 C.

See also Railway Engineering, Motive Power and Equipment.

Lubrication.

The Theory of Lubrication Reduced to Practice. J. K. Nye. On the importance of understanding the correct lubricating qualities for the purpose intended. 2000 w. Marine Engng—April, 1903. No. 54493 C.

Marine Engine.

A Marine Engine with Corliss Valve Mechanism. William H. Crawford, Jr. An account of the compound engine placed in the Steamer City of Puebla, now running in the service of the Pacific Coast Steamship Co. Ill. 1200 w. Marine Engng—April, 1903. No. 54494 C.

Mechanical Draft.

See Electrical Engineering, Generating Stations.

Mechanical Stokers.

Mechanical Stokers Depending Upon the Coking Method of Firing. Albert A. Cary. A discussion before the New England Cotton Mfrs. Assn. Gives an illustrated description of the coking method of firing, considering its advantages and disadvantages, and discussing forms of mechanical stokers. 6000 w. Engr, U S A—April 1, 1903. No. 54570 C.

Piping.

Pipe Work for Electric Lighting Stations. Suggestions for the arrangement of steam-pipe work of small or medium sized stations, recommending the header system. Ill. 2500 w. Elec Engr, Lond —March 27, 1903. No. 54520 A.

Smoke Prevention.

The Prevention of Smoke from Bituminous Coal. Charles H. Benjamin. A discussion of ways of securing the conditions necessary for perfect combustion, the devices tried and the results attained, favoring mechanical stokers. 3000 w. Engr, U S A—April 1, 1903. No. 54575 C.

Steam Turbines.

High Superheating with Steam Turbines (Die Anwendung Hoher Ueberhitzung beim Betrieb von Dampfturbinen). Ernst Lewicki. A very complete illustrated record, with diagrams and tables, of tests made at the Dresden technical high school on a de Laval steam turbine, using highly superheated steam. Serial. Three parts. 13000 w. Zeitschr d Ver Deutscher Ing—March 28, April 4 and 11, 1903. No. 54803 each D.

The Curtis Steam Turbine. W. L. R. Emmet. An illustrated paper, read before the American Philosophical Society, giving description of a development based upon the original theories and inventions of C. G. Curtis. Claims important advantages over other types. 2500 w. St Ry Jour—April 11, 1903. No. 54678 D.

A New Steam Turbine. Brief illustrated description of the Curtis steam turbine. 800 w. Elec Rev, N Y—April 11, 1903. No. 54672.

Modern Development of the Steam Turbine. Frank C. Perkins. General remarks with brief accounts of the Rateau, Curtis, Parsons and other types. Ill. 2900 w. Sci Am—April 25, 1903. No. 54909.

The Rateau Turbine. An illustrated description of this type which is extensively used abroad. 1800 w. St Ry Jour —April 18, 1903. No. 54750 D.

Superheating.

A Remarkable English Engine. Illustrated article, reporting a remarkable performance of a steam engine of moderate size, built by Easton & Co. for the British Xylonite Co. and using the Schmidt system of superheating. 1200 w. Am Elect'n—April, 1903. No. 54483.

Valve Gears.

Layout of Corliss Valve Gears. Sanford A. Moss. Gives a method for laying out a Corliss or other similar valve gear, using as a starting point the desired percentages of compression and release. Ill. 5800 w. Am Mach—April 9, 1903. Serial. 1st part. No. 54585.

The Elsner Valve Gear (Die Elsner-Ventilsteuerung). Georg W. Koehler. An illustrated description of a valve gear for steam engines, in which the amount of steam admitted is automatically regulated, illustrations of engines, and valve diagrams and their discussion. Serial. Part I. 1000 w. Glasers Annalen—March 15, 1903. No. 54822 D.

Wire-Drawing.

Notes Relating to the De Laval Steam Turbine, the Wire-Drawing Calorimeter, and the Superheating of Steam by Wire-Drawing. Prof. W. H. Watkinson. Read before the Inst. of Engrs. and Shipbuilders in Scotland. Discusses problems relating to the wire-drawing of steam. Ill. 1200 w. Prac Engr—March 27, 1903. Serial. 1st part. No. 54529 A.

MISCELLANY.

Bicycles.

Bicycles for Touring (Les Bicyclettes. Le Concours de Bicyclettes de Tourisme). Carlo Bourlet. An illustrated account of a road competition for bicycles in France and descriptions of brakes and other details. 2500 w. Génie Civil—March 14, 1903. No. 54860 D.

Drawings.

Numbering and Filing Drawings. S. A. Worcester. An outline of a system recommended, with a brief comparison with other methods. 1800 w. Am Mach —April 16, 1903. No. 54701.

Enameling Machine.

The Dupont Process of Enameling Large Hot Castings (Rapports sur l'Emaillage à Chaud des Pièces de Fonte de Grandes Dimensions d'après le Procédé de M. P. Dupont). Ach. Livache and P. Dupont. An illustrated description of a machine and process for enameling large objects, such as bath tubs, by spraying the enamel on in a closed chamber. 3000 w. Bull Soc d'Encouragement—March 31, 1903. No. 54843 G.

Engineers.

The Mechanical Engineer, His Duties, Responsibilities, and Opportunities. William H. Bryan. Address before the Washington Univ. Assn., St. Louis, Mo. 4500 w. Engr, U S A—April 15, 1903. No. 54745 C.

We supply copies of these articles. See page 475.

Heating and Ventilation.

Ventilating and Heating in the Palace of the Crown Prince of Japan. Light, heat and power is supplied by a boiler and engine plant in a separate building. Exhaust steam is employed for heating; the fresh air supply is furnished by six fans. All the apparatus is of American make. 2200 w. Eng Rec—April 4, 1903. No. 54560.

Ventilation and Heating of Rockefeller Hall, Vassar College. Describes the system adopted in this two-story and basement building, which covers a ground area of 11,540 sq. ft. 2000 w. Eng Rec—April 25, 1903. No. 54900.

Heating and Ventilating of Railroad Shops. J. I. Lyle. Considers the systems adapted to the use of exhaust steam, favoring the fan system. General discussion. 9500 w. N Y R R Club—March 20, 1903. No. 54707.

Kites.

The New Observation Kites Invented by S. F. Cody. An illustrated description of the apparatus which has proved practical and successful for general observation and meteorological experiments. 1100 w. Sci Am Sup—April 11, 1903. No. 54669.

Mechanics.

The Definition of Mechanical Phenomena (Définition des Phénomènes. Application de la Mécanique des Systèmes Matériels). A. Gouilly. A discussion of natural phenomena and the fundamental conceptions and "laws" of mechanics. Diagrams. 9000 w. Mem Soc Ing Civils de France—Feb., 1903. No. 54839 G.

Refrigerating Machine.

Tests of an Ammonia Refrigerating Machine (Versuche an einer Ammoniak-Kompressionskältemaschine). Rich Stetefeld. An illustrated description of a test of an ammonia-compression refrigerating machine built by the Halle Machine Works. 1200 w. Zeitschr d Ver Deutscher Ing—April 4, 1903. No. 54806 D.

Refrigeration.

Carbonic Anhydride Refrigerating Machinery for Marine Use. S. H. Bunnell. States the advantages of carbonic anhydride as a refrigerant, and describes machinery recently installed on new vessels. Ill. 3500 w. Eng News—April 9, 1903. No. 54588.

Shutting Down Ice Plants and Preparing Them for the Summer Season. William Nottberg. Reviews things of importance to have plants in proper order. 1800 w. Power—April, 1903. No. 54430 C.

Sand-Blast Cleaning.

See Civil Engineering, Materials.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

Briquet Fuel. W. H. Booth. Information relating to the making and use of briquets in various countries. 3000 w. Engr, U S A—April 1, 1903. No. 54564 C.

Coke Ovens.

Progress in the Heating of Horizontal Coke Ovens in the Last Twenty Years (Fortschritte in der Beheizung der Liegenden Koksöfen in den Letzten Zwanzig Jahren). An account of the construction of coke ovens and the methods of firing, heating and conducting the air and gases. 3000 w. Stahl u Eisen—March 15, 1903. No. 54828 D.

A Modern Coke Oven. Illustrates and describes the by-product ovens, ordinary and patent ovens of the Fabry-Linard System, stating the advantages claimed. 2000 w. Ir & Coal Trds Rev—March 20, 1903. No. 54409 A.

Coking.

Coking Badly Caking Coal. Illustrates apparatus and describes a new mechanical process for coking such coal. 800 w. Ir & Coal Trds Rev—April 3, 1903. No. 54654 A.

Firedamp.

Outbursts of Firedamp in Mines. A review of experimental investigations and a statement of theories advanced to explain these accumulations of firedamp and guard against the terrible consequences attending outbursts. 3000 w. Col Guard—April 3, 1903. No. 54650 A.

Germany.

Lignite, Peat and Coal-Dust Fuel in Germany. A supplementary report relating more especially to the utilization of these deposits. 3300 w. U S Cons Repts, No. 1615—April 8, 1903. No. 54542 D.

Heating Values.

Coals, Their Sources and Heating Values. John W. Langley. Concerning the origin, distribution in the United States, analyses of coals and cokes, and heating power. 1800 w. Engr, U S A—April 1, 1903. No. 54568 C.

Illinois.

Coal Mines and Zinc Works at La Salle, Illinois. A. Dinsmore. A description of

mining plant at La Salle shaft, and of the Matthiessen & Hegeler zinc works. 2800 w. Mines & Min—April, 1903. No. 54-441 C.

Northwestern States.

Coal Fields of the Northwestern States. Arthur L. Westcott. An account of the deposits in the portion of the United States known as the Rocky Mt. States. The character varies from lignite beds in North Dakota, to the anthracite of Colorado. 3000 w. Engr, U S A—April 1, 1903. No. 54569 C.

Tonkin.

The Coal Mines of Tonkin (Les Charbonnages du Tonkin). F. Schiff. A well illustrated description of some of the coal mines of French Indo-China and their exploitation. 3000 w. Génie Civil—March 14, 1903. No. 54859 D.

Valuation.

The Valuation of Coals. E. L. Rhead. Read before the Manchester (Eng.) Soc. of Chem. Ind. Brief discussion of methods of determining the specific gravity, moisture, ash, coking power, volatile matter, sulphur, calorific power, etc. 4000 w. Ir & Coal Trds Rev—April 3, 1903. No. 54653 A.

COPPER.

Matting.

Some Personal Experience on Matting of Ores at Leadville and Robinson, Colo. Gives results obtained, with the view of counteracting some ideas prevalent concerning capacity of furnace. 1700 w. Eng & Min Jour—April 11, 1903. No. 54693.

Smelting.

Late Improvements in Copper Smelting. Herbert Lang. From Trans. California Miners' Assn. On the changes and improvements of recent years; the pyritic process and what it has effected; other processes, and cost. 2800 w. Min & Sci Pr—April 11, 1903. No. 54736.

New Copper Smelting Plant at Rio Tinto. Illustrations of the blast furnaces and converters, with brief description of plant. 1100 w. Ir & Coal Trds Rev—Mar 20, 1903. No. 54408 A.

The Elimination of Arsenic, Antimony, Lead and Zinc from Copper Mattes. S. E. Bretherton. A brief description of the smelting practice at the Val Verde Copper Co.'s works, showing that it is not necessary to do any preliminary roasting as the objectionable elements are sufficiently eliminated in blast furnace smelting. 1800 w. Min & Sci Pr—April 4, 1903. No. 54632.

Treatment.

The Payne-Gillies Process for the Treatment of Copper Ores. James Taylor. Describes a process designed to deal with cupriferous ores, concentrates and tailings in cases where smelting would be inadmissible. 1500 w. N Z Mines Rec—Feb. 16, 1903. No. 54413 B.

GOLD AND SILVER.

Alloys.

On Certain Properties of the Alloys of the Gold-Silver Series. Sir W. C. Roberts-Austen and T. K. Rose. Read before the Royal Soc. Gives results of experiments made to obtain homogeneous trial plates by which the standard of the coinage may be tested. 800 w. Metallographist—April, 1903. No. 54612 F.

Australia.

The Minerals of West Australia. Information of value, taken from a bulletin recently issued by the Departmental Laboratory of the Western Australia Geological Survey. Gold is by far the most important mineral. 2500 w. Engr, Lond—March 27, 1903. No. 54504 A.

Colorado.

The Silver Lake Mine, near Silverton, San Juan County, Colo. Prof. Arthur Lakes. An instance of successful operation of a large mine at high altitude is described. Ill. 2200 w. Mines & Min—April, 1903. No. 54440 C.

The Camp Bird Mine, Ouray, Colorado, and the Mining and Milling of the Ore. Chester Wells Purington, Thomas H. Woods, and Godfrey D. Doveton. Gives a description of this property, its history, geology and working; also a description of the mill, the method and cost of treating the ore. Ill. 16000 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54613 D.

Cripple Creek.

The Lodes of Cripple Creek. J. A. Rickard. An illustrated article explaining the occurrence of the ores and the geology of the district. 9500 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 54614 D.

Dredging.

Gold-Dredging in New Zealand. C. Edward Turner, in the *Mining Journal*, London. An account of its inception, progress and practice. 6000 w. N Z Mines Rec—Feb. 16, 1903. No. 54412 B.

The Stewart River Gold Dredge. A. W. Robinson. A brief description, with illustrations. 2800 w. Can Min Rev—March 31, 1903. No. 54534 B.

Hydraulic Mining.

Hydraulicking Low-Grade Gravel. P. Bouery. Gives results obtained in working placers, showing that low grades can be worked with some profit. 1400 w. Min & Sci Pr—April 18, 1903. No. 54926.

We supply copies of these articles. See page 475.

Klondike.

Mining Methods on the Klondike. Eugene Haanel. An explanation of the methods, machinery and appliances used. Ill. 3900 w. Eng & Min Jour—April 11, 1902. No. 54694.

Mongolia.

Silver-Mining and Smelting in Mongolia. Benjamin Smith Lyman. A discussion of Mr. Y. T. Woo's paper. 1200 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54618 C.

New Zealand.

Mining in the Hauraki Gold Fields. From the *New Zealand Herald.* A review of the past year's operations. 4500 w. N Z Mines Rec—Feb. 16, 1903. No. 54411 B.

Slimes.

Treatment of Slime in Tanks with Conical Bottoms. Illustration of plant with description of its operation. 1100 w. Eng & Min Jour—March 28, 1903. No. 54437.

South Africa.

Mining Methods at Johannesburg. T. Lane Carter. Notes on methods of handling ore in the deep-level mines, methods of managing the workmen, the working of the contract system and related matters. 1800 w. Eng & Min Jour—April 18, 1903. No. 54760.

Observations on the Rand Conglomerate. L. De Launay. Discusses their origin and occurrence, giving theories explanatory of the formation. 4500 w. Eng & Min Jour—April 4, 1903. No. 54539.

South Dakota.

Cambrian Ore Deposits in the Black Hills. Describes these deposits which carry a greater value in gold than in silver, and carry but little lead. 1500 w. Min & Sci Pr—April 4, 1903. No. 54633.

Veins.

The Veins of Boulder and Kalgoorlie. T. A. Rickard. An illustrated description of the veins of Boulder Co., Colorado, and the lodes of Kalgoorlie, West Australia, showing their geological unlikeness. 2000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 54617 C.

IRON AND STEEL.

American Practice.

The Steel Works Practice of the United States. Enoch James. Read before the Conference of the Brit. Ir. Trd. Assn. Calls attention to points where American practice may with advantage and profit be imitated by English manufacturers. 3500 w. Ir & Coal Trds Rev—April 3, 1903. No. 54655 A.

Blast Furnaces.

Flue-Dirt and Top-Pressure in Iron Blast Furnaces: A Study of the Influences Controlling Them. F. Louis Grammer. A study of flue dirt and influences controlling it, based on observations of about thirty furnaces. 4000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 54616 D.

The Modern Blast Furnace Laboratory and Its Work. W. Dixon Craig. A non-technical paper considering the work of the laboratory, and the laboratory itself, with notes on some of the methods of chemical analysis used. 1600 w. Can Min Rev—March 31, 1903. No. 54532 B.

Blooming Mill.

Blooming Mill of the Röchling Iron and Steel Works. Translated from *Stahl und Eisen.* Illustrated description. 1200 w. Engng—April 10, 1903. No. 54728 A.

Cette, France.

Blast Furnace and Iron Work at Cette. Translated from *Le Genie Civil.* Illustrated description of these works, especially the blast furnace construction. 2200 w. Engr, Lond—March 27, 1903. No. 54503 A.

Continuous Mill.

The Modern Continuous Rolling Mill. Axel Sahlin. Read before the Staffordshire Ir. & Steel Inst. An illustrated article describing mills investigated during a tour of study and inspection in the United States. 9600 w. Ir & Coal Trds Rev—March 27, 1903. No. 54506 A.

Electric Reduction.

See Electrical Engineering, Electro-Chemistry.

High-Speed Steels.

The Structure of High-Speed Steels. E. L. Rhead. Suggests a possible explanation of the behavior of rapid cutting steels. 800 w. Engr, Lond—April 3, 1903. No. 54662 A.

Hot Blast.

Process for Equalizing the Temperature of Hot Gases (Verfahren zum Ausgleichen der Temperatur heisser Gase). Walter Daelen. A brief, illustrated account of the Giers and Harrison method of equalizing the temperature of the hot gases in blast-furnace work, and temperature records of the hot blast taken by the Uehling-Steinbart pyrometer. 600 w. Stahl u Eisen. April 1, 1903. No. 54832 D.

Ingot Molds.

The Durability of Ingot Molds (Haltbarkeit van Kokillen). P. Reusch. An illustrated discussion of the causes which affect the durability of ingot molds for

steel works, such as their material and its treatment, their shape and thickness, and their handling. 2000 w. Stahl u Eisen—March 15, 1903. No. 54827 D.

The Durability of Ingot-Molds. P. Reusch. Abstract translation of a recent article in *Stahl und Eisen* on the proper design and handling. Ill. 1200 w. Ir Age—April 23, 1903. No. 54762.

Metallography.

On the Industrial Importance of Metallography. Albert Sauveur. Abstract of a paper, considering only iron and steel, and showing the commercial application of metallography. Discussion. 3000 w. Jour Fr Inst—April, 1903. No. 54459 D.

Meteoric Iron.

Meteoric Iron from N'Goureyma, near Djenne, Province of Macina, Soudan. E. Cohen. Description with analysis and illustrations. 2200 w. Am Jour of Sci—April, 1903. No. 54465 D.

Puddled Iron.

Puddled Iron and Mechanical Means for the Production of Same. James P. Roe. Also discussion by Joseph Hartshorne. An explanation, with illustrations, of the process developed by the writer. 3500 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54624.

Siemens-Martin Process.

The Dissociation of Carbonic Oxide in the Regenerator of Siemans-Martin Furnaces (Zersetzung des Kohlenoxydgases in Wärmespeicher des Martinofens). Franz Würtenberger. Analyses of gases made at the steel works of the Soc. Lig. Metallurgica, Italy, by Dr. Mambrini, and discussion of the results and their causes. 1200 w. Stahl u Eisen—April 1, 1903. No. 54831 D.

Slag Cement.

See Civil Engineering, Materials.

Spain.

The Iron Ore Mines of Biscay. Bennett H. Brough. An illustrated article describing the country, people, mines, &c., methods employed, transportation and output. 2700 w. Cassier's Mag—April, 1903. No. 54463 B.

Steel.

The Constitution and Thermal Treatment of Steel. H. M. Howe. Reprinted from an article in the *Encyclopedia Britannica*. Considers the microscopic entities which constitutes the different varieties of iron and their effect when subjected to thermal treatment. 3500 w. Metallographist—April, 1903. No. 54609 F.

Steel Rails.

The Rolling and Structure of Steel Rails. P. H. Dudley. A report upon recent practice, giving a study of structure and tests. Ill. 4000 w. Metallographist—April, 1903. No. 54611 F.

MINING.

Deep Mining.

Underground Temperatures in Relation to Deep Mining. F. G. Meachem. Abstract of paper read before the S. Staffordshire & E. Worcestershire Inst. of Min. Engrs. A study of the earth's temperature and its variations. Also discussion. 3300 w. Col Guard—April 17, 1903. No. 54950 A.

Electric Hoisting.

See Electrical Engineering, Power Applications.

Geology.

The Geologist in Matters of Practical Mining. J. E. Spurr. A discussion of the value of this science in mining, and its practical application. 1800 w. Eng & Min Jour—April 11, 1903. No. 54692.

Hoisting.

Hoisting from Great Depths. Hans C. Behr. Abstract from the Johannesburg *Star*. An abstract of Mr. Behr's reply to the discussion of his paper read before the South African Assn. of Engrs. 2800 w. Eng & Min Jour—April 25, 1903. Serial. 1st part. No. 54927.

Hoisting from Great Depths. Robert Peele. A discussion of conclusions reached by H. C. Behr in his paper on "Winding Plants for Great Depths," giving also the writer's views. 4800 w. Eng & Min Jour—April 4, 1903. No. 54538.

Mapping.

Graphic Method of Mapping Exposed Ore Bodies. G. W. Miller. Describes a method that has been tested and used extensively with satisfaction, and been found especially adapted for ore deposits lying in continuous sheets, or those of the fissure vein, or bedded types. Ill. 2800 w. Min & Sci Pr—March 28, 1903. No. 54536.

Miners' Phthisis.

Miner's Phthisis. William Cullen. Discusses the cause and remedy for this disease so prevalent among miners. 5000 w. Jour Chem & Met Soc of S Africa—Feb., 1903. No. 54640 E.

Mine Ventilation.

Improvised Ventilating Machinery. C. M. Myrick. Describes simple appliances for inducing air currents. 1200 w. Min & Sci Pr—April 11, 1903. No. 54734.

Mining Machinery.

Notes on Accidents Due to Combustion within Air Compressors. Albert R. Ledoux. Describes a casualty due to lack of judgment and care in the use of air compressors. 1000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 54620.

We supply copies of these articles. See page 475.

Ore Deposits.

Ore Deposits at Butte, Montana. Walter Harvey Weed. Abstract from Bul. of the U. S. Geol. Survey. An outline of the main features. Ill. 3000 w. Eng & Min Jour—April 18, 1903. No. 54759.

Pumping.

The Cost of Pumping at the Short Mountain Colliery of the Lykens Valley Coal Company. R. V. Norris. Describes the conditions prevailing at these mines, the pumping plant, and the cost of pumping. Ill. 1400. Trans Am Inst of Min Engrs—Feb., 1903. No. 54622.

Shaft Linings.

Shaft Linings. An account of the different types of lining which have been employed. Ill. 3700 w. Col Guard—March 27, 1903. No. 54507 A.

Valuation.

Mining Engineering in the Valuation of Mines. G. W. Miller. A brief discussion of educational qualifications of mining engineers and their duties. 1500 w. Min & Sci Pr—April 11, 1903. No. 54733.

Water Hoisting.

Water-Hoisting in the Pennsylvania Anthracite Region. R. V. Norris. Describes the present method of hoisting, giving particulars of the water hoists in use and under construction and related information. Ill. 3800 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 54615 D.

MISCELLANY.

Aluminum.

The Present Position of the Aluminum Industry. John B. C. Kershaw. The present article reviews the production and price. 1600 w. Elec Rev, Lond—March 20, 1903. Serial. 1st part. No. 54418 A.

Azores.

Geological Features of the Azores. O. H. Howarth. Gives interesting illustrations of peculiar volcanic effects both past and present. 5500 w. Mines & Min—April, 1903. No. 54439 C.

Death Valley.

Death Valley. Don Maguire. Describes this most desolate spot in North America, its history, inhabitants, and products. 4000 w. Mines & Min—April, 1903. No. 54443 C.

Furnace Bottoms.

Truck Support for Furnace-Bottoms. Henry A. Mather. Illustrates and describes this device, stating its advantages. 600 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54619.

German East Africa.

Mining Regulations of German East Africa. Translation of the mining regulations and rules, with general information. 3300 w. U S Cons Repts, No. 1607—March 30, 1903. No. 54403 D.

Great Salt Lake.

The Mineral Crest, or the Hydrostatic Level Attained by the Ore-Depositing Solutions, in Certain Mining Districts of the Great Salt Lake Basin. Discussion of Dr. W. P. Jenney's paper, by George Otis Smith and S. F. Emmons. 1100 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54623.

Mica.

Mica—Its Uses and Value. Charles C. Schnatterbeck. Information in regard to deposits and their quality, method of mining, uses, &c. 900 w. Eng & Min Jour—March 28, 1903. No. 54438.

Mine Accounting.

See Industrial Economy.

Nickel.

Progress in the Metallurgy of Nickel During 1902. Titus Ulke. Reviews the development in various districts and the processes used. 2800 w. Eng & Min Jour—April 25, 1903. No. 54929.

Development in the Nickel Industry at Sault Ste. Marie, Ontario, Canada. E. A. Sjostedt. Gives results obtained at Sault Ste. Marie in the roasting of mono-sulphides without the aid of auxiliary heat. 1200 w. Eng & Min Jour—April 25, 1903. No. 54930.

Ore-Deposition.

The Chemistry of Ore-Deposition. Walter P. Jenney. A study of the action of carbon and hydrocarbons, their combinations, and the relative reducing power of minerals. 17700 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 54625 D.

Petroleum.

The Russian Petroleum Trade. Information regarding the production of crude oil in the Baku fields, prices at the wells, refining, transportation, new fields, &c. 6700 w. U S Cons Repts, No. 1609—April 1, 1903. No. 54458 D.

The Present Oil Situation in Colorado. Prof. Arthur Lakes. A review of the histories of the several regions, and the discoveries which have been made. Ill. 3200 w. Mines & Min—April, 1903. No. 54442 C.

St. Louis Fair.

Mining and Metallurgy at the St. Louis World's Fair, 1904. Prof. Joseph A. Holmes. Information in regard to the proposed exhibits and what they are intended to show. 1200 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 54621.

Stamp Cams.

See Mechanical Engineering, Power and Transmission.

We supply copies of these articles. See page 475.

Zinc.

Zinc Industry in Europe. Information on the production and consumption of zinc in various European countries. 4000 w. U S Cons Repts, No. 1625—April 20, 1903. No. 54702 D.

The Zinc Mines at Ellenville, N. Y. Axel O. Ihlseng. Plan of the mine with brief account of the development. 500 w. Eng & Min Jour—April 25, 1903. No. 54928.

Zinc Works.

See Mining and Metallurgy, Coal and Coke.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in February. Condensed record of the principal accidents, with notes on the more serious ones. 3000 w. R R Gaz—April 3, 1903. No. 54555.

Train Accidents in the United States in March. A condensed record of the principal accidents, with remarks. 2500 w. R R Gaz—April 24, 1903. No. 54925.

A Remarkable Accident. Brief illustrated account of the collapse of a bridge span in Arizona, while a train was passing. 600 w. Ry Age—April 10, 1903. No. 54680.

MOTIVE POWER AND EQUIPMENT.

Bearings.

"Anti-Friction" Car Side Bearings and Center Plates. Gives results of tests made on the Pittsburg & Lake Erie road, showing a marked effect on train resistance. 700 w. Am Eng & R R Jour—April, 1903. No. 54479 C.

Coal Car.

Canadian Pacific Coal Car. Illustrated description of cars of 40 tons capacity, of the latest design, aiming to eliminate all tendencies toward sagging or bulging. 600 w. Loc Engng—April, 1903. No. 54453 C.

Fuel.

Petroleum Oil vs. Coal as Fuel. Arguments favoring the use of oil. 600 w. Loc Engng—April, 1903. No. 54455 C.

Locomotive Frame.

The Locomotive Steel Frame and Its Repairs. A. W. McCaslin. Presented before the Ry. Club of Pittsburg. Discusses the many failures of steel frames and how the repairs should be made. 2500 w. Ry & Engng Rev—April 25, 1903. No. 54959.

Locomotives.

A Caledonian Locomotive Giant. Charles Rous-Marten. States the conditions to be met, and gives illustration and description of the engine designed. 2000 w. Engr, Lond—April 3, 1903. No. 54661 A.

Acceleration and Velocity Curves Obtained with the New Midland Compound Express Engines. Gives interesting diagrams showing the accelerating power of the fine three-cylinder compound engines recently put on this line. 500 w. Engng—March 27, 1903. No. 54512 A.

American and Foreign Locomotives. Editorial discussing points in these locomotives, methods of drafting in America, and other points of interest. Gives particulars of the performance of foreign engines also. 2000 w. Loc Engng—April, 1903. No. 54454 C.

Atlantic Type Locomotive for the Baden State Railways (Locomotive Type "Atlantic" des Chemins de Fer de l'Etat Badois). F. Barbier. An illustrated description of a four-cylinder-compound, Atlantic-type locomotive built by Maffei, of Munich. 1 Plate. 2500 w. Génie Civil—March 14, 1903. No. 54861 D.

Atlantic Locomotive for Pennsylvania Lines. Illustrated description of the class E-2a engines, for the Northwest system of the Pennsylvania lines. General dimensions are given. 1000 w. Ry Age—March 27, 1903. No. 54428.

Experimental Tandem Compound Freight Locomotive. Illustrates and describes an engine of the 2-8-0 type, class G-2a for freight service. 1400 w. Am Engr & R R Jour—April, 1903. No. 54477 C.

Four-Cylinder Compound Locomotives for the Jura-Simplon Railway (Note sur la Locomotive Compound à 4 Cylindres de la Compagnie des Chemins de Fer du Jura-Simplon). Camille Barbey. An illustrated description of compound locomotives, with three pairs of drivers and a bogie truck forward, built at Winterthur, and also a plan and profile of the Jura-Simplon Railway through Switzerland. 2 Plates. 2000 w. Rev Gén des Chemins de Fer—April, 1903. No. 54850 H.

Four Cylinder Compounds in Europe. Reginald Gordon. Illustrates an engine showing recent German practice, and gives comparative tables showing weights and dimensions of four-cylinder compound locomotives. 800 w. R R Gaz—April 10, 1903. No. 54593.

Great Eastern 3-Cylinder 10-Wheeled

We supply copies of these articles. See page 475.

Coupled Tank Engine. Illustrated description of an engine designed for accelerated service on a suburban system. 1000 w. Mech Engr—April 4, 1903. No. 54643 A.

Locomotive Construction in the United States. A review of information from the census report with interesting comments on the conditions which necessitated great changes in the railroad transportation systems. 3000 w. Sib Jour of Engng—April, 1903. No. 54627 C.

Locomotives for the Mediterranean Railway. Illustrates and describes recently completed engines of the compound type, having four axles coupled and a four-wheeled bogie. They were designed for heavy trains on mountain lines. 1000 w. Engng—March 27, 1903. No. 54514 A.

Mikado (2-8-2) Compounds for the Atchison. Illustrated detailed description of Vauclain compound freight locomotives to be used on a mountain division having a maximum grade of 185 ft. per mile. 600 w. R R Gaz—April 3, 1903. No. 54552.

Recent Types of Powerful British Goods Locomotives. Illustrations and brief account of some of the recent types of goods locomotives built for work on British systems. 2500 w. Transport—April 3, 1903. No. 54637 A.

Rock Island Consolidation (2-8-0) Locomotive. Illustrated general description with notes on the features of interest. 700 w. R R Gaz—April 17, 1903. No. 54757.

Motor Car.

A Steam Railway Coach. Illustrations, with brief description, of a new steam-driven motor coach to be run on English railways. 500 w. Engr, Lond—April 10, 1903. No. 54723 A.

Train Resistance.

New Determinations of the Resistance of Locomotives and Trains at High Speeds (Neuere Ermittlungen über die Widerstände der Lokomotiven und Bahnzüge mit Besonderer Berücksichtigung Grosser Fahrgeschwindigkeiten). Prof. Albert Frank. Discussions of experiments made on railways in Hanover to determine frictional, air and other resistances of locomotives and trains at speeds up to 100 kilometers an hour. Diagram. 4000 w. Zeitschr d Ver Deutscher Ing—March 28, 1903. No. 54804 D.

Valve Design.

Proposed Design of Locomotive Valves for High Speeds. J. V. N. Cheney. A brief discussion giving the writer's views. 900 w. R R Gaz—April 10, 1903. No. 54594.

Wheels.

The Ehrhardt Patent Seamless Spoke-Wheel. R. M. Daelen. Describes this wheel and states the advantages claimed. 700 w. Ir & Coal Trds Rev—April 3, 1903. No. 54652 A.

Chilled Cast Iron Car Wheels. C. H. Vannier. Read before the students of Purdue Univ. Detailed description of the method of manufacture, and testing, with remarks. 5000 w. Foundry—April, 1903. No. 54602.

NEW PROJECTS.

Australia.

South Australia's Land-Grant Railway. Hon. J. H. Gordon. Discusses this scheme for the construction of a railway across Australia. Map. 2400 w. Rev of Revs—April, 1903. No. 54467 C.

Denver-Salt Lake.

Geology and Economics Along the Line of the New Moffat Railway to be Built from Denver to Salt Lake City. Prof. Arthur Lakes. Map and brief description of an interesting region both geologically and economically. 1500 w. Mines & Min—April, 1903. No. 54444 C.

Location.

Some Theories upon Railroad Location. J. G. Kerry. A discussion of factors of importance, especially from a Canadian point of view. Maps. 11000 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54545 D.

Seaham-Hartlepool.

The New Seaham and Hartlepool Line. Brief illustrated description of a line 9½ miles in length, which gives much easier gradients, and opens a new coal field. An important addition to the North-Eastern Railway System of England. 2200 w. Transport—April 3, 1903. No. 54636 A.

Transandine.

The Transandine Railway. An illustrated description of the finished portion on the Argentine side of this interesting new line which will connect with the State railways of Chile. 1500 w. Ry & Engng Rev—April 11, 1903. No. 54681.

Trans-Canada.

The Trans-Canada Railway. E. T. D. Chambers. A discussion of this projected line, the directness of the route, its military importance, high altitudes, &c. Map. 2000 w. Rev of Revs—April, 1903. No. 54466 C.

Wabash.

The Greater Wabash. An illustrated general account of the new construction extending the Wabash railroad to Pittsburg and the coast. 2500. Ry Age—April 24, 1903. No. 54960.

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PERMANENT WAY AND FIXTURES.

Albula.

The Albula Railway from Thusis to St. Moritz, Switzerland (Die Albula-Bahn von Thusis nach St. Moritz). H. Cox. An illustrated description of the construction of a railroad through a very difficult mountain region, involving many bridges and tunnels, the main tunnel being 5866 meters long. Map and profile. 1500 w. Zeitschr d ver Deutscher Ing—March 21, 1903. No. 54801 D.

Coal Pockets.

Local Coal Pockets for the Lehigh Valley R. R. at Newark, N. J. Walter G. Berg. Illustrated detailed description of recently constructed pockets with modern improvements. 1200 w. Eng News—April 2, 1903. No. 54549.

Drainage.

Drainage of English Railroads. Edward Davy Pain. An illustrated article showing typical methods of treating slopes and of draining cuttings. 2700 w. R R Gaz—April 3, 1903. No. 54554.

Erie Terminals.

New Erie Terminals at Jersey City and New York. An illustrated account of extensive changes to be made in Jersey City and Manhattan, including ferry-houses, office building, new station, tracks and yards, &c. 1300 w. R R Gaz—April 24, 1903. No. 54924.

Fencing.

Railway Fencing. R. W. Leonard. A discussion of this subject, the most economical and efficient type, cost, &c. Also considers cattle guards. 1600 w. Can Soc of Civ Engrs, Adv Proof—April, 1903. No. 54708.

Russia.

Railway Construction in Russia. Details from an historical sketch of the rise and progress of the Russian railway system, published in a recent number of the Russian *Official Messenger*. 1300 w. Engr, Lond—March 20, 1903. No. 54404 A.

Shops.

Car Shops of the Rochester Railway. An illustrated detailed description of new shops, equipped for car building and for the construction and repair of apparatus. 4200 w. St Ry Jour—April 11, 1904. No. 54677 D.

Improvements at the Topeka Shops of the Atchison, Topeka & Santa Fé Ry. Illustrates and describes the plans for a complete reconstruction and rearrangement of a plant for heavy locomotive work. 4500 w. Eng News—April 2, 1903. No. 54547.

Shop Improvements of the Pennsylvania at Columbus. An illustrated description of the extensive improvements of the general shops at Columbus, Ohio. 1700 w. Ry & Engng Rev—April 11 and 17, 1903. Serial, 2 parts. No. 54682.

Signals.

Automatic Signal Location. Shows the importance of the proper location, calling attention to points that should be considered. 2000 w. Ry Age—April 3, 1903. No. 54540.

Low Pressure Power Interlocking at Salisbury, England. Drawings showing the layout of tracks with description of the working. 900 w. R R Gaz—April 3, 1903. No. 54553.

The Safe Course. Charles Hansel. Arguments favoring the equipping of railroads with automatic signals and showing that a successful system must be designed to be a check on the engineer, but not to supersede him. 1800 w. Eng News—April 2, 1903. No. 54548.

See also Street and Electric Railways.

Tunnel.

See Civil Engineering, Construction.

Turn-Table.

Pneumatic Turntable. Illustrates and describes a high-speed compressed air turntable recently installed at Trenton, N. J. 600 w. R R Gaz—April 17, 1903. No. 54758.

TRAFFIC.

Rates.

Equated Tonnage Rates—Methods of Test and Calculation. Max H. Wickhorst. A discussion of engine rating; methods of determining the tractive force, friction, train resistance, &c., giving tables and diagrams. Also general discussion. 12000 w. W Ry Club—March 17, 1903. No. 54703 C.

Railway Freight Rates. J. N. Faithorn. An address before the College of Engng. of the Univ. of Wisconsin. Gives a general description of rate adjustments made necessary by changed conditions, outlining the prevailing systems. 5400 w. Wis Engr—Feb., 1903. No. 54606 D.

MISCELLANY.

Accounting.

The Distinction Between Repairs and Improvements, and a Proposed Classification of Railroad Maintenance of Way Expenses. Walter G. Berg. Abstract of a paper before the Am. Ry. Engng. & Maintenance of Way Assn. 1500 w. Eng Rec—April 4, 1903. No. 54559.

Tests.

Test Departments. C. W. Gennet, Jr. Considers the object of the test department in railroading, and the method of carrying on the work. 2400 w. R R Gaz—April 10, 1903. No. 54592.

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STREET AND ELECTRIC RAILWAYS

Boston.

The Street Traffic in the City of Boston. Charles Prelini. An illustrated article describing the conditions and the difficulties, and the construction of the subway. 7700 w. Trac & Trans—April, 1903. Serial. 1st part. No. 54901 E.

See also Civil Engineering, Construction.

Cincinnati.

The Cincinnati, Georgetown & Portsmouth Railroad Changed from Steam to Electric Traction. E. M. Stevens. Illustrates and describes the electrical apparatus installed, the power plants and substations. 2500 w. Elec Rev, N Y—April 4, 1903. No. 54535.

Colorado Springs.

The Colorado Springs & Interurban Street Railway System. J. H. Rusby. An illustrated description of the electrical equipment and the power installation. 2000 w. Elec Rev, N Y—April 25, 1903. No. 54787.

Flat Cars.

Working Drawings for an Electric Flat Car. Arthur B. Weeks. Description with drawings. 700 w. St Ry Jour—April 25, 1903. No. 54932 D.

Germany.

Transportation Problems and Progress in Germany. Reports a constant improvement, considering the development of the Berlin electric railways, the State railways and electric traction on canals. 2000 w. U S Cons Repts, No. 1618—April, 1903. No. 54598 D.

High Speed.

High Speed Electric Traction. Arthur L. Cook. Reviews the various systems that have been brought forth and the types of apparatus employed, and discusses the classes and apparatus best suited to each. 8300. Jour Worcester Poly Inst—March, 1903. No. 54604 C.

London.

Locomotion and Transport in London. Edward Davy Pain. An account of the task awaiting the Royal Commission which was appointed to investigate and report concerning means of locomotion and transport. 3000 w. R R Gaz—April 24, 1903. No. 54923.

The Movement of London. T. C. Elder. A statement of conditions in London, and the traffic problems. A discussion of the work to be undertaken by the Royal Commission. 3600 w. Trac & Trans—April, 1903. No. 54902 E.

Mersey Railway.

The Electrification of the Mersey Railway. Gives a review of the history of this tunnel railway connecting Liverpool with Birkenhead, and an account of the recently completed electrification of the entire line. 4000 w. St Ry Jour—April 4, 1903. No. 54563 D.

Multiple Unit.

The Sprague Multiple-Unit System of Electric Traction (Le Système Sprague pour la Commande des Trains Electriques à Motrices Multiples). Jean de Traz. A comprehensive account of this electric traction system, with many diagrams and illustrations. 6500 w. Bull Soc Internationales des Electriciens—March, 1903. No. 54848 H.

New York.

Rapid Transit in New York. Hon. Robert P. Porter. An outline of the schemes under way and prospected in New York, with comments. 2500 w. Engng—April 10, 1903. No. 54726 A.

New York Subway.

The Subway of New York. Charles Prelini. Comments on the plan presented by William Barclay Parsons, and of other improvements in transportation facilities. 2000 w. Engng—March 27, 1903. No. 54510 A.

New Zealand.

The Auckland Electric Tramways. An illustrated detailed description of electric lines recently constructed in this flourishing town in New Zealand. 3500 w. Tram & Ry Wld—March 12, 1903. No. 54420 B.

Ohio.

Ohio Central Traction System. An illustrated description of the construction and operation of the Mansfield, Crestline and Galion line, which is a part of this system. 2800 w. St Ry Jour—April 25, 1903. No. 54931 D.

Operation.

Possibilities in the Direction of Improving Operating Practice. Remarks on benefits derived from inspection tours to other shops and from good railway literature. 3000 w. St Ry Jour—April 25, 1903. No. 54934 D.

Paris Metropolitan.

The North Circular Section of the Paris Metropolitan Railway (Le Chemin de Fer Metropolitain de Paris, Ligne Circulaire, Nord par les Boulevards Exterieurs). Raymond Gadfernoux. A well illustrated

We supply copies of these articles. See page 475.

description of the section of the Metropolitan electric railway of Paris, which follows the line of the northern exterior boulevards, partly in viaduct, but principally underground. 3 Plates. 6500 w. Rev Gén des Chemins de Fer—April, 1903. No. 54849 H.

Philadelphia.

The Philadelphia Rapid Transit System. W. W. Wheatley. Explains the organization and growth of the system, reports expenses, earnings, &c., in the present issue. Ill. 3300 w. St Ry Jour—March 28, 1903. Serial. 1st part. No. 54434 D.

Subway Structures of the Philadelphia Rapid Transit Company. Illustrated detailed description of the proposed construction of a concrete steel subway. 2500 w. Eng Rec—April 18, 1903. No. 54765.

Pittsburg, Pa.

The Street Railway System of Pittsburg, Pa. An illustrated article giving information of the finances, lines, rolling stock, power plants, &c. 9000 w. St Ry Rev—April 20, 1903. No. 54772 C.

See also Civil Engineering, Canals, Rivers and Harbors.

Rockford-Janesville.

Rockford, Beloit & Janesville Railroad—Power Plant, Operation and Equipment. Illustrates and describes an interurban road, in Illinois and Wisconsin, supplied by alternating-current transmission with rotary converter substations. Gives records of the power house and substation performance. 2500 w. St Ry Jour—April 25, 1903. No. 54933 D.

San Francisco.

New Power Plans of the United Railways of San Francisco. Illustrates and describes the new central power station and its equipment, and the three substations which are now in course of construction. 3300 w. St Ry Jour—April 18, 1903. No. 54749 D.

Signalling.

Signalling on Single Line Tramways. Lionel E. Harvey. Brief account of hand-operated and automatic systems in use. 1300 w. Elec Rev, Lond—April 17, 1903. No. 54945 A.

Snow.

Snow Fighting in Buffalo. Illustrates and describes the snow-fighting apparatus used. 1800 w. St. Ry Jour—March 28, 1903. No. 54435 D.

Speeds.

Schedule Speeds on Electric Railways. W. Park. A study of the maximum schedule speed, and things affecting it. 1100 w. Tram & Ry Wld—March 12, 1903. No. 54422 B.

Standard Railways.

The Electric Operation of Standard Railways (Neues aus dem Gebiete Elektrischen Betriebes für Vollbahnen). Hr. Reichel. An illustrated paper before the "Verein für Eisenbahnkunde" on high-speed electric railways for heavy traffic, with high voltages, with reference to the zossen and other German experimental work. 7000 w. Glasers Annalen—April 1, 1903. No. 54823 D.

Electric Traction on Steam Railways. Alton D. Adams. Discusses the systems tried, their cost, advantages and disadvantages. 2200 w. Cassier's Mag—April, 1903. No. 54464 B.

Stray Currents.

See Electrical Engineering, Electro-Chemistry.

Surface Contact.

The Schuckert Surface Contact Tramway System. Brief illustrated description of this system which is to be tested in England. A trial section in Munich was pronounced satisfactory. 2000 w. Engng—March 27, 1903. No. 54511 A.

Schuckert Surface Contact System. An illustrated description of the present designs as a whole, improvements having been recently made. 1600 w. Tram & Ry Wld. March 12, 1903. No. 54423 B.

Third Rail.

Third Rail Contact. George T. Hanchett. Discusses the troubles caused by sleet accumulations, and calls attention to some practical experiences which have reference to the commercial practicability of the third rail and contact shoe. Describes devices tried and offers suggestions. 2000 w. Tram & Ry Wld—March 12, 1903. 54421 B.

Tokyo.

Tokyo Street Railway and Foreign Capital. A draft of the agreement by which a British syndicate will supply the Japanese company with needed capital; also some information regarding the attitude of the Japanese to foreign capital. 1000 w. Engr, Lond—March 20, 1903. No. 54405 A.

Tunnel.

See Civil Engineering, Construction.

Valtelline.

High Tension Polyphase Electric Traction as Applied on the Valtelline Railway [Traction par Moteurs Triphasés à Haute Tension (Système Ganz et Cie.) Appliquée sur la Ligne de la Valteline]. D. Korda. An illustrated comprehensive article on the Valtelline electric railway in Italy, built on the Ganz tri-phase system, and a discussion of high tension polyphase traction in general. 10,000 w. Bull Soc Internationale des Electriciens—March, 1903. No. 54847 H.

We supply copies of these articles. See page 475.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Coal Strike Report.

Report of the Anthracite Coal Strike Commission. Bulletin of the Department of Labor. No. 46—May 1, 1903. Edited by Carroll D. Wright. Size, 9 by 5¾ in.; pp. vi, 247. Washington, D. C.: The Department of Labor.

This Commission was appointed by the President of the United States to consider the questions at issue between the coal miners and the operators which led up to the great strike of 1902, and to make awards which should be binding for three years. While abstracts of this report were given in newspapers and other periodicals upon its issue, so that its general tenor is well known, it is nevertheless very interesting and instructive to read the unabridged version, with its various appendices. The report proper gives a general review of the conditions in the anthracite coal regions, and a history of events leading up to the strike. The testimony presented before the Commission is then discussed, and the awards are given in full, together with the reasons which were determining with the Commissioners,, who were Judge George Gray, Gen. John M. Wilson, Bishop John L. Spalding, Mr. E. W. Parker, Mr. E. E. Clark, Mr. Thomas H. Watkins, and Col. Carroll D. Wright, as recorder. The appendices contain the statements of the parties to the case; the earnings of mine workers; details of mine operation; constitution of the United Mine Workers of America; a plan, proposed by the Commission, for an organization for the execution of trade agreements; a bill, proposed by Mr. Charles Francis Adams, providing for compulsory investigation and publicity, and other matter. Altogether, the report is one of the most important contributions to the discussion of the labor question that has ever been made, and should be carefully studied no less by the business man and manufacturer than by the sociological student.

Electro-Chemistry.

Kalender für Elektrochemiker, sowie Technische Chemiker und Physiker für das Jahr 1903. VII. Jahrgang. With supplement. By Dr. A. Neuburger. Size, 6½ by 4½ in.; pp. 583, in supplement, 448; figures and tables. Price, 4 marks ($1.25). Berlin: M. Krayn.

Since the first edition of this calendar and hand-book was issued in 1896, the practical applications of electro-chemistry have increased enormously, and in the present edition of this work a successful effort has been made to keep pace with the advance of the industry. The calendar occupies only a small portion of the book, the greater part of which, as well as the whole of the supplement, being filled with tables and information useful to electro-chemists in particular, and also to chemists and physicists in general. Among the topics treated are: Electrical units and measurements; atomic weights; specific weights; solubility; chemical analysis; electrolysis; conductivity of electrolytes; polarization; electromotive forces of various cells; electro-chemical and thermo-electric generation of currents; accumulators; quantitative electrolysis; technical electrolysis, and various branches thereof; mathematical tables; physics, including general mechanics, heat and optics; technical mechanics and machines; fuels and heating; patents laws of Germany, and of the other leading states; other German laws and regulations, and general information.

Induction Motor.

The Induction Motor, Its Theory and Design Set Forth by a Practical Method of Calculation. By Henri Boy de la Tour. Translated from the French by C. O. Mailloux, M. A. I. E. E., M. I. E. E. Size, 9¼ by 6¼ in.; pp. xxvii, 200; figures, 75. Price, $2.50. New York: McGraw Publishing Co.

The object of this work, as stated in the preface, is "to give a complete study of the polyphase non-synchronous (induction) motor, and to explain at length all the peculiarities of its operation, while remaining within the bounds of elementary mathematics." The author is well and favorably known in Europe as a contributor to the French elecrical periodicals, being an authority on the subject discussed in the present volume, and he is now introduced to the English-reading public under most favorable auspices, as the translator is peculiarly fitted for his

work, both from a technical and a linguistic standpoint. After a review of the theory of the revolving (or rotary) field, the principles of the induction motor are taken up and its design worked out analytically and graphically, with a free use of figures and diagrams. Many details and modifications are considered, so that the work will be especially valuable to the designer who is obliged to satisfy the requirements of everyday practice. At the request of the translator, the author has prepared, for this American edition, a chapter on the Heyland induction motor, which is designed to operate with a power factor of unity under all loads. The translator, in an interesting introduction, has made a valuable contribution to technical nomenclature, discussing the meanings and definitions of various words used in both the French original and the English translation. This not only prevents any ambiguity in the meaning of the terms employed in this book, but also helps to give greater exactness and clearness to electrical terminology in general.

Irrigation.

Irrigation Institutions. A Discussion of the Economic and Legal Questions Created by the Growth of Irrigated Agriculture in the West. By Elwood Mead, C. E., M. S. Size, 7½ by 5¼ in.; pp. xi, 392. Figures. Price, $1.25 (postage, 12 cts.). New York: The Macmillan Company. London: Macmillan & Co., Ltd.

The opening years of the twentieth century have brought a larger and truer conception of the value of the arid West and of the part it is to play in the industrial life of the United States. The American nation has been awakened to the opportunities here presented, and the civic pride of Western communities has been aroused to secure the creation of irrigation codes which will be worthy of a self-governing people. As an aid to local effort, the general government is engaged in gathering facts on which future developments should be based. The Department of the Interior is measuring the water supply, and the Department of Agriculture is studying the methods of distributing and using water in order to promote its more skilful and effective use, and is inquiring into the social and legal questions created by the use of streams in irrigation, both in the United States and in other countries. From its beginning the author has been in charge of the latter investigation, and the present work is based on his twenty years of experience in the development of irrigated agriculture in the West. The lessons of these years is that the vital agricultural problem of the arid West is to establish just and stable titles to water and provide for their efficient protection in times of need, and the purpose of this book is to lead to a better understanding of this problem and so to further its wise and just solution. After several chapters devoted to a general review and discussion of irrigation in the western part of America, the conditions prevailing in the several arid States are described, and a concluding chapter treats of the methods and measures needed for future development. This volume forms one of the "Citizens' Library of Economics, Politics and Sociology," and will prove of great interest to all who are concerned with irrigation, and particularly to those who have the growth and prosperity of the Western United States at heart.

Mechanics.

An Elementary Treatise on the Mechanics of Machinery, With Special Reference to the Mechanics of the Steam Engine. By Joseph N. Le Conte. Size, 7¼ by 5½ in.; pp. x, 311; figures, 212; plates, xv. Price, $2.25. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

The present work is the outcome of a course of lectures on kinematics and the mechanics of the steam engine, which has been issued in the form of notes to students in the department of mechanical engineering of the University of California for several years past. The first two parts embody the more important principles of what is generally called the kinematics of machinery, though in many instances dynamic problems which present themselves are dealt with, the real purpose of the book being the application of the principles of mechanics to certain problems connected with machinery. In the third part is discussed the mechanics of the steam engine, that machine being considered perhaps the most important from a designer's point of view. Here the subject is treated under two distinct heads, kinematics and dynamics. Appendices contain discussions and proofs of problems and theorems in kinematics, and an index completes a volume which makes a highly satisfactory text-book, the topics being well handled and clearly illustrated.

Railroad Construction.

Railroad Construction. Theory and Practice. A Text-Book for the Use of Students in Colleges and Technical Schools. By Walter Loring Webb, C. E. Second edition. Size, 6¾ by 4½ in.; pp. xvii, 675; figures, 232, including halftones and folding plates. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The first edition of this book was issued about three years ago in octavo size, but

as this form was inconvenient for use in the field, it was decided to recast the whole work and reduce the page to pocket-book size. Advantage was taken of the opportunity to revise freely and to add new matter, the original text being now almost doubled. Among the new chapters are some on structures, train resistance and rolling stock, and several giving the fundamental principles of the economics of railroad location. The latter make up the second part of the book, and supply, in clear and interesting form, extremely valuable information, which is too often neglected by engineers, and particularly by young ones, who concentrate their attention upon the technical side of railroading, when the economic side is often of superior importance. Other chapters treat of surveys, and the construction of the permanent way, with accounts of the most modern forms of superstructure, block signaling, brakes, etc., the sections on earthwork and on transition curves being particularly full and valuable. There are many useful tables in convenient form, a good index and a large number of illustrations. While the book is intended primarily for students, it will prove very useful to any railroad engineer, in either the field or the office.

Railway Engineers.

Manual for Resident Engineers, Containing General Information on Construction. By F. A. Molitor and C. J. Beard. Size, 7½ by 4¾ in.; pp. iv, 118; plates, diagrams and tables. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The authors of this book are, respectively, the chief engineer and the principal assistant engineer of the Choctaw, Oklahoma and Gulf Railroad, and in the course of the construction of this company's lines they first issued part of the present volume in blue-print form and afterwards published the whole in book form for the use of their road, with the satisfactory result that each of the fifty or more resident engineers was able, without verbal explanations and instructions, to comply with the standards required, and to obtain uniformity of method in both work and results. The first part of this manual contains general information on construction, reports and the duties of resident engineers. This is followed by standard general specifications for graduation, masonry and lumber, and an abstract of a general form of contract, and in the latter portion of the book are tables of level cuttings, to be used for preliminary work only, giving the cubic yards in prismoids 100 feet long for various breadths of base and heights. This convenient little manual, which has been so useful on one railroad, should now prove of equal service to the railroad engineering profession in general, and will no doubt receive the welcome it deserves.

Steel Analysis.

The Analysis of Steel Works Materials. By Harry Brearley and Fred Ibbotson. Size, 9 by 6 in.; pp. xv, 501; figures, 85. Price, 14s. ($5). London, New York, and Bombay: Longmans, Green & Co.

In this volume the analysis of steel-works materials is dealt with on such lines as could profitably be followed in a large and busy works laboratory, so that the book is an eminently practical one and should prove most useful to steel-works chemists, besides being an excellent text-book for students. The different parts are devoted to the analysis of steel; analysis of pig iron; analysis of steel-making alloys; rapid analysis at the furnace; analysis of ores; analysis of refractory materials; analysis of slags; analysis of fuel; boiler water, boiler scales, etc.; analysis of engineering alloys, including copper alloys and white metal alloys; micrographic analysis of steel; pyrometry, and miscellaneous notes. In the part on micrographic analysis, there is A. L. Colby's complete bibliography of works on the metallography of iron and steel, published before the foundation of the *Metallographist*, and an appendix to the volume contains a comprehensive bibliography of steel-works' analysis compiled from the *Chemical News*, *Journal of the Society of Chemical Industry*, *Journal of the Iron and Steel Institute*, and *Journal of the Chemical Society*. There are illustrations of apparatus and a number of good micrographs, and the book, besides its intrinsic merit, has an attractive appearance and is very well made.

Steel Treatment.

Hardening, Tempering, Annealing and Forging of Steel. By Joseph V. Woodworth. Size, 9¼ by 6 in.; pp. 288; figures, 201. Price, $2.50. New York: Norman W. Henley & Co.

In preparing this work the author has paid particular attention to the requirements of the metal-working mechanic, and has written a treatise on the practical treatment and working of high and low grade steel, comprising the selection and identification of steel, the most modern and approved heating, hardening, tempering, annealing and forging processes, the use of gas-blast forges, heating machines and furnaces, the annealing and manufacturing of malleable iron, the treatment and use of self-hardening steel, with special reference to case-hardening processes, the hardening and tempering of milling cutters and press tools, the use of machinery steel for cutting tools, forging and welding, high-grade steel forgings in

America, forging of hollow shafts, drop-forging, and grinding processes for tools and machine parts. With the object of giving to practical men a book describing the treatment of steel for tools of all kinds, the author has drawn upon a personal experience of many years, and has, besides, gathered and arranged all available information from other sources. The uses to which the leading brands of steel may be adopted are discussed, and their treatment for working under different conditions explained, and in the volume are various "kinks" and practical points which help to make it useful to the metal worker and machinist. Considering the revolution which is being made in machine-shop practice by the introduction of the new high-speed tool steels, this work is a most timely and valuable one, as it gives some of the latest information concerning the manufacture and employment of this modern material.

Wood.

The Principal Species of Wood: Their Characteristic Properties. By Charles Henry Snow, C. E., Sc. D. Size, 10½ by 7 in.; pp. xvi, 203; figures in the text and 39 full-page half-tones. Price, $3.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

In this book the most important species of wood, from an economic standpoint, are described and illustrated, and their principal characteristics are discussed. The order of procedure followed here is to give a general and historical sketch of the genus, with illustrations of the full-grown tree, leaves, nuts, and bark, and sections of the wood. The principal species are then taken up and their following characteristics are detailed: Nomenclature; locality; features of trees; color, grain or appearance of wood; structural qualities of wood; representative uses of wood; weight of seasoned wood; modulus of elasticity; modulus of rupture; general features. Among the genera thus treated are: Oak; ash; elm; maple; walnut; hickory; chestnut; beech; sycamore; birch; locust; tulip-tree; poplar or cottonwood; willow; catalpa; buckeye; teak; mahogany; eucalyptus; pine; spruce; fir; hemlock; cedar; cypress; redwood; palm; and bamboo. Most of the woods here considered are those native to North America, and, as before remarked, emphasis is laid particularly upon their engineering and economic qualities. The data are derived from the author's own observations, from U. S. Government reports and from other standard sources. There is a bibliography and an index. The book is well made, has some fine illustrations, and should prove a valuable contribution to the literature of engineering materials.

Yacht Building.

Small Yacht Construction and Rigging. By Linton Hope. Size, 9½ by 6½ in.; pp. 177; plates 4; many illustrations and figures. Price, $3. New York: Forest and Stream Publishing Co.

Boat building is a very interesting hobby, and for yachtsmen who are desirous of gaining that intimate knowledge of their boat which is obtained only by constructing it themselves, this book will prove a helpful guide. The first part of the volume, after giving general directions about tools, materials and methods of construction, contains complete designs for two boats: a 22-foot, center-board, jib-and-mainsail boat, and a 24-linear-rating fast cruiser, with topsail-sloop rig and a small cabin. The second part relates particularly to the rigging, and describes different sail plans and gives their comparative advantages and disadvantages. The metal work and various other details are treated fully, and many illustrations help to make the book a useful one for the amateur yacht builder.

BOOKS ANNOUNCED.

The Copper Handbook. 1903 Edition. By Horace J. Stevens. Price, $5 (in buckram), $7.50 (in full morocco). Houghton, Mich.: Horace J. Stevens.

Statics by Algebraic and Graphic Methods, Intended Primarily for Students of Engineering and Architecture. By Lewis J. Johnson, C. E. Price, $2. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Improvement of Rivers. A Treatise on the Methods Employed for Improving Streams for Open Navigation, and for Navigation by Means of Locks and Dams. By B. F. Thomas and D. A. Watt. Price, $6 (postage, 47 cents). New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A Handbook on the Steam Engine. Third English Edition, Revised. By Herman Haeder. Translated from the German by H. H. P. Powles. Price, $3. New York: D. Van Nostrand Company. London: Crosby, Lockwood & Son.

Heating and Ventilating Buildings. A Manual for Heating Engineers and Architects. Fourth edition. By Rolla C. Carpenter, M. S., C. E., M. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Gold Dredging, the New Industrial. Price, 25 cents (paper), 50 cents (cloth). Chicago: Bunting & Van Asmus.

Ninth Annual Report of the Commissioner of Public Roads for the Year Ending October 31, 1902. Trenton, New Jersey: Office of Commissioner of Public Roads.

NEWS SUPPLEMENT

The Engineering Magazine—June, 1903

American Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

AMERICAN FOUNDRYMEN'S ASSOCIATION. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 9-11, Milwaukee.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual convention, June 29-July 3, Niagara Falls. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

AMERICAN PARK AND OUTDOOR ART ASSOCIATION. Sec.: C. M. Robinson, Rochester, N. Y. Annual meeting, July 7-9, at Buffalo.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting Oct. 28, at Richmond, Va.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 24-26, Saratoga Springs, N. Y.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August. Annual convention, June 8, Asheville, N. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.; Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting, June 22-26, at Saratoga Springs, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS. Sec.: Prof. Edgar Marburg, University of Pennsylvania. Convention July 1, 2 and 3, at the Delaware Water Gap.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

AMERICAN WATER-WORKS ASSOCIATION. Sec.: J. M. Diven, Elmira, N. Y. Annual meeting, June 23-26, Detroit.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday, from October to May, inclusive.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September, Atlantic City, N. J.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LEAGUE OF AMERICAN MUNICIPALITIES. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 29 to July 1, Saratoga Springs, N. Y.

MODERN SCIENCE CLUB. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

MONTANA SOCIETY OF ENGINEERS. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Next meeting, July 15-17, at Detroit.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston, Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.; G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct 13, 14 and 15, at Kansas City, Mo.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, July 1-3, at Niagara Falls.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Willis G. Dodd, who has been connected with the Union Iron Works, of San Francisco, for many years, has recently been elected president of that company.

—Messrs. H. B. Coho & Company, the contracting engineers of 114 Liberty Street, New York, have issued a tasteful pamphlet, with views of some of the plants they have equipped.

—Mr. W. O. Duntley, vice-president and general manager of the Chicago Pneumatic Tool Company, has recently returned from a short business trip abroad in the interests

of his company. While on the Continent, Mr. Duntley visited several of the most prominent shipyards, manufacturing establishments, etc., and brought back with him a large number of orders for the various pneumatic appliances manufactured by his company.

—Mr. John A. Caldwell, formerly with the American Stoker Co., has now become the general sales manager of the Wilkinson Manufacturing Co., of Bridgeport, Pa., with offices at 45 Broadway, New York.

—Mr. George Welsby Scott, the consulting engineer, has removed from "The Rookery" to larger offices in the Security Building, Chicago, where increased facilities will enable him to more fittingly care for the interests of those intrusting to him matters within the lines of general engineering.

—Mr. S. Morgan Smith died recently at Los Angeles, Cal., after an illness lasting several months. He was the founder and head of the S. Morgan Smith Co., of York, Pa., the well-known manufacturers of water wheels and power transmitting machinery.

—Mr. A. Rieppel, Koeniglicher Baurat, of Nürnberg, Germany, the managing director of the Augsburg-Nürnberg Manufacturing Co., well known for many years as one of the largest and most successful builders of structural iron work, engines, cars, bridges, etc., in Europe, is now visiting this country for the first time. Mr. Rieppel's visit to this country was made to interest the Allis-Chalmers Company in the manufacture of the products of his company, and by mutual agreement to enable each or either of them to get into closer touch with the requirements of the trade throughout the world. A contract was entered into by the two companies, giving the Allis-Chalmers Company the exclusive right to manufacture and sell the Nürnberg gas engine for this country and selling rights in many foreign countries, especially the far east and South Africa. The Augsburg-Nürnberg Manufacturing Company, under the direction of Mr. Rieppel, have made a phenomenal success with this new gas engine, having within the past few months received orders for some 50,000 H. P. throughout Germany and Spain, chiefly for generating electric energy and for blast-furnace and spinning-mill work.

Industrial Notes.

—The Brown Corliss Engine Co., of Corliss, Wis., are looking for a number of good agencies to handle their work in different parts of the country.

—The New York, Ontario & Western Railway, whose main line extends from New York City to Oswego, N. Y., on Lake Ontario, and which has branches to Kingston, N. Y., Scranton, Pa., Utica, N. Y., and Rome, N. Y., has some desirable factory sites, with water power, along its line that would pay manufacturers to look into. The freight shipping facilities for raw material in, and the finished product out, are of the best. Call on, or address, J. C. Anderson. General Freight Agent, 56 Beaver Street, New York City.

—The American Committee on Standard Specifications for Cast Iron and Finished Castings recently held a meeting in Philadelphia, for organization. Mr. Walter Wood, the chairman, appointed sub-committees on pig iron, pipe, cylinders, car wheels, malleable cast iron, general castings, and testing cast iron. The reports of these sub-committees will be referred to the full committee, and afterwards to the International Congress for Testing Materials. It is desired that progress reports shall be ready to be submitted to the meeting of the full American Committee at the Delaware Water Gap meeting of the American Society for Testing Materials, on July 1, 2 and 3.

The romantic and beautiful situation of the new "Royal Muskoka" hotel, located in the heart of one of the most magnificent summer resort districts in America, the "Highlands of Ontario," bordering on Georgian Bay, inspires anticipations of the most pleasant sort. Every comfort and luxury that modern civilization has given us is found in this great hotel, which can accommodate 350 people. There is direct telegraph service with the hotel, which is about six hours' journey north of Toronto, with excellent transportation service, furnished by the Grand Trunk Railway. Illustrated descriptive literature giving all particulars regarding routes and rates, etc., can be had on application to F. P. Dwyer, Eastern Passenger Agent of the Grand Trunk Railway System, Dun Building, 290 Broadway, New York.

—The M. Garland Co. have installed conveyors, in which over a mile of cable has been used, for the Union Bag & Paper Co., at Sandy Hill, N. Y., for conveying pulp wood. This is claimed to be the largest installation for this purpose in the United States, if not in the world.

—Pratt & Whitney Co., of Hartford, Conn., the well known manufacturers of machine tools, have issued a neat daily memorandum pad, called the "Wisdom Calendar," with extracts from George H. Lorimer's "Letters from a Self-Made Merchant to His Son."

—The constantly increasing demand for Christensen air brakes and "Ceco" electrical machinery has made necessary a change in the organization of the Christensen Engineering Company. To accomplish this result, the owners of the stock of this company have organized the National Electric Company, and the assets, good will, etc., of the Christensen Co. have been transferred to the National Electric Co., the purposes, ownership, management and control of the new company being identical with those of the old.

—The Lunkenheimer Company, Cincinnati, report that on account of the unprecedented demand for their superior line of brass and iron steam specialties, they have been compelled to increase their foundry output 50 per cent. Machine tools of the most improved type are being installed in various departments as fast as they can be obtained.

—The American Blower Co., of Detroit, Mich., has recently opened offices in Philadelphia and Pittsburg. The former is at 615 Hale Building, in charge of Mr. Benj. Adams, ,and the latter at 318 Frick Building, in charge of Mr. H. P. Curtiss.

—The output of Lake Superior graphite is controlled by the Detroit Graphite Manufacturing Company. This company's plant is equipped with its own peculiar machinery for fine grinding and mixing, the result of many years of study and experience. Their graphite paints are in use on all kinds of engineering work throughout the country. Their machinery paints are well known for their efficiency for all grades of work. In fact, this company is prepared to meet any problem in the paint line. Further information can be had by addressing The Detroit Graphite Manufacturing Co., Detroit Mich.

—The Tabor Mfg. Co., of Philadelphia, has arranged with The Draper Co., of Hopedale, Mass., for the manufacture and sale of the hand rammed molding machines, which the latter firm has been building for its own use. The Draper Co. has had probably the longest experience in molding by machinery of any firm in this country, and consequently their machines represent the result of years of experimenting, including the trying of many other machines now on the market. At present they have in operation in their Hopedale plant several hundred of these machines. They are on wheels and are light and cheap, and do not require power to operate them.

—A very clever device for double indexing blank books, has just been placed on the market by Mr. John C. Moore, of 127 Stone Street, Rochester, N. Y. It consists of a small steel "Movable Marker" which is slipped over the outer edge of the leaf, so as to be in a line with a series of figures or letters which are attached to the extreme edge of the book, making it an easy matter to arrange the records both alphabetically and according to date, at the same time in the same book. The manufacturer of this valuable device has recently published a book containing nearly one hundred pages of useful information on the subject of scientific accounting by the loose-leaf method, which he will gladly forward gratuitously, to any one sufficiently interested to ask for it.

—The Standard Paint Company, manufacturers of the well-known Ruberoid roofing and the P & B products, was organized in 1886 with Ralph L. Shainwald as president; Silas S. Packard, since deceased, vice-president, and Felix Jellinik, secretary and treasurer. Mr. Shainwald and Mr. Jellinik have continuously held their offices since. Mr. Max Drey is the present vice-president. The first factory was erected at Bound Brook, N. J., on a part of the site of the present works. The Standard Paint Company were the first to place upon the market an odorless, water-proof insulating paper, and the first to make a liquid insulating compound which could be applied without heat and which therefore supplied a long felt need in the electrical field. They were also the first manufacturers of a ready roofing (Ruberoid) which was odorless, weather-proof and elastic. In view of

the very excellent quality of these manufactures it was but natural that the demand should be enormous. This demand has so steadily increased as to grow beyond the capacity of the works, and extensions of the plant and purchases of additional land have been continuously necessary from the beginning. The latest addition to the works is a building from 350 to 375 feet in length, which was recently the scene of a housewarming party, given by the Standard Paint Company to their employees, with whom they have always maintained the most cordial relations.

—The Philadelphia Pneumatic Tool Co. has furnished all the pneumatic tools for the erection of forty-five steel bridges that the Southern Pacific Company are erecting incident to the straightening of their line between Ogden, Utah, and Reno, Nevada. Large orders for chipping hammers, riveters and drills have been received, also, from the Baldwin Locomotive Works, American Car & Foundry Co., Pennsylvania Steel Co., American Bridge Co., Vulcan Iron Works, Toledo, and the Lake Shore & Michigan Southern Ry.

—The Rand Drill Company report the removal of their San Francisco office from 223 First St., to the Rialto Building, additional space being needed because of the rapidly expanding business of this company on the Coast.

—E. P. Roberts & Company, consulting engineers, Electric Building, Cleveland, Ohio, announce that owing to the increasing demands of their eastern business they have opened a branch office at 25 Broad Street, New York City. This office has been placed under the management of William C. Andrews, E. E., eastern representative of the company, and will provide greatly increased facilities for following the interests of their clients.

—The Power Specialty Company, of New York, have received orders from the Wellman-Seaver-Morgan Engineering Co., for a superheater similar to the one they installed for them in Oct., 1901; from the Enterprise Mfg. Co., of Philadelphia, for three superheaters to be exact duplicates of one they installed for them in Oct., 1902; from E. Keeler Co. for a superheater to be installed in the Jersey Shore plant of the Williamsport Passenger Railway Co.; from the Massachusetts Electric Co. for a superheater to be installed in their Quincy power station to superheat the steam for a 3,000-kilowatt Curtis turbine; and from the Carbondale Machine Co. for a superheater to be used in connection with an ice machine they are building.

—Owing to the necessity of obtaining more room, Robert W. Hunt & Co. have moved their New York office to No. 66 Broadway. Messrs. John J. Cone and James C. Hallsted, of the firm, sailed for Europe recently on the Campania, the former returning abroad after a few weeks' visit home. Mr. Hallsted has gone over to give his personal supervision to the inspection of the structural material for two large London hotels, which has been awarded to his firm. These contracts, together with several others for buildings to be erected in England and South Africa, as well as for the bridge material for this continent, has compelled the firm to organize a foreign structural and bridge department, in addition to the one in charge of rails, splice bars, billets, etc., etc.

—The Webster, Camp & Lane Company, of Akron, Ohio, and The Wellman-Seaver-Morgan Engineering Company, of Cleveland, O., have consolidated under the new corporate name of The Wellman-Seaver-Morgan Company. The general offices of the new company will be located at Cleveland, Ohio, to which address all general correspondence and remittances should be sent. Correspondence for the Akron plant should be addressed to the Webster-Camp-Lane Division of The Wellman-Seaver-Morgan Company, Akron, Ohio. The officers of the new company are as follows: President, S. T. Wellman, Cleveland; chairman, John McGregor, Akron; 1st vice-president, S. H. Pitkin, Akron; 2nd vice-president, J. W. Seaver, Cleveland; 3rd vice-president, G. H. Hulett, Cleveland; general manager, C. H. Wellman, Cleveland; secretary, T. R. Morgan, Cleveland; treasurer, A. D. Hatfield, Cleveland. The new company will continue the lines of work of the two old companies, and with the two modern plants working together, they are in position to make prompt deliveries, and guarantee the very best workmanship and material, on any requirements which may be in their line of work. The

engineering department is one of the largest and most comprehensive in the world, and they offer their services as consulting and contracting engineers in general practice.

—Allis-Chalmers Company, Chicago, U. S. A., announce that the general offices of the company are now located in the New York Life Building, 14th floor, corner of La Salle and Monroe Streets.

—Messrs. Spon & Chamberlain, the well-known publishers and importers of technical books, have issued a series of sheets containing a set of specifications for the design and testing of continuous-current dynamos, based on Prof. Silvanus P. Thompson's book on the "Design of Dynamos."

—The Eureka Fire Hose Co. is building an extension to its factory in Jersey City, that will afford additional space needed by its twisting and weaving departments. The extension is about 118 by 50 feet, with four floors, and will make the total area of the company's main brick factory about three acres. This main building will be 399 feet in length, averaging 90 feet in width, and four stories in height. The extension, like the present building, will be built and equipped in accordance with most approved factory insurance practice. The machinery to be installed will be electrically driven, and the electric lighting, telephone and fire alarm systems of the present mill will be extended into the new structure. The extension is an evidence of the intention of the Eureka Fire Hose Co. to continue to maintain for its factory the reputation that it has borne for more than a quarter century, as the largest and most perfectly equipped fire hose factory in the world.

—The Loomis-Pettibone Company have removed their New York offices from No 52 Broadway to 52 and 54 William Street. They have recently increased their capitalization to $2,000,000, and are about to begin the construction of a large plant, near New York, for the manufacture of gas engines in large units, in addition to the Loomis-Pettibone gas apparatus, which they will continue to manufacture as heretofore. The name of the new company is the Loomis-Pettibone Gas Machinery Company, and its officers and directors are: Benjamin Guggenheim, president; Cyrus Robinson, 1st vice-president and general manager; Burdett Loomis, Jr., 2nd vice-president and manager sales department; Leon P. Feustman, secretary and treasurer; Burdett Loomis, Sr., consulting engineer; Hawley Pettibone, chief engineer; Charles E. Finney. The company is now prepared to enter into contracts for the equipment of complete plants, gas generators, gas engines, and electric generators and motors. Until their own plant is ready to turn out large gas engines, they will deliver the engines manufactured by Crossley Brothers, Ltd., Manchester, England, for which they have the exclusive agency for North America. The Loomis-Pettibone Co. have installed a number of large gas-engine plants in the United States and Mexico, and call attention particularly to the following installations: Minas Tecolotes y Anexas, Guggenheim Exploration Co., owners, Santa Barbara, Chihuahua, Mexico; capacity, 700 H. P.; Montezuma Copper Co., Phelps, Dodge & Co., owners, Nacosari, Sonora, Mexico; capacity, 1,000 H. P.; Detroit Copper Mining Co., Phelps, Dodge & Co., owners, Morenci, Arizona; capacity, 1,000 H. P.; Winchester Repeating Arms Co., New Haven, Conn.; capacity, 1,000 H. P. They have also recently closed contracts for a number of other power plants in Mexico and the United States. The Loomis-Pettibone Co. are producing power with a consumption of 2½ pounds of wood per brake horse-power hour, or with one pound of good bituminous coal. The economic production of power under all conditions with such installations is therefore apparent. This company call the attention of all users of power to the careful consideration of the above facts, and will be pleased to furnish any information that may be desired.

—During the last four months, the Pacific Department of the Pelton Water Wheel Co. has received contracts for water wheels for the largest and most important hydro-electric plants west of Niagara. In every instance, the wheels must conform with the speed of the generators, to permit of direct connection, and as the heads under which they operate are of both extremes, viz., from 65 feet to 2,100 feet, some idea of the adaptability and vast range of Pelton apparatus in this comparatively new industry, may be imagined.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue A, illustrating and describing the many types of the American air compressors, air receivers, vacuum pumps, carbonic-acid-gas and high-pressure compressors, and the American air-lift pumping system, with information about pneumatic tools and a table showing the flow of air through various sized orifices. 9 by 6 in.; pp. 54. American Air Compressor Works, 26 Cortlandt St., New York.

Air Pumps.

Catalogue, with illustrations and description of the Edwards patent air pump, for marine and stationary engines, with steam or electric drive. 5½ by 8½ in.; pp. 14. Wheeler Condenser & Engineering Co., 120 Liberty St., New York.

Accumulators.

Bulletins, devoted to installations of "Chloride Accumulators" at the Alum Rock station of the San Jose and Santa Clara Railway Co., San Jose, Cal., Edison stations in Brooklyn and New York, and other electric light and power plants. 10½ by 8 in. The Electric Storage Battery Co., Philadelphia.

Blue-Printing Machine.

Circular describing and illustrating an automatic lamp controller for a cylindrical electrical copier, for making blue prints by electric light. 9 by 6 in.; pp. 4. Pittsburg Blue Print Company, Pittsburg.

Boilers.

Circular No. 117, giving a description of a boiler shop, a list of users of boilers, and illustrations of works, shop interior and high grade boilers. 11½ by 9 in.; pp. 4. Lombard Iron Works and Supply Company, Augusta, Georgia.

Core Ovens.

Catalogue, with descriptions and full-page illustrations of Millett's patent core oven for foundry purposes, which has swinging shelves with rear doors for closing the opening to oven when shelves are open. This oven is also made in portable form. Testimonials and long list of users. 9½ by 7½ in.; pp. 32. Millett Core Oven Co., Brightwood, Mass.

Drop Forgings.

Pamphlet containing the story of John Stevens and his sons and their many remarkable inventions and contributions to engineering progress. Also, illustrations of gear blanks, crank shafts and other high grade drop forgings. 7 by 4½ in.; pp. 12. Wyman & Gordon, Worcester, Mass.

Electric Conduit.

Circular, with illustrations and description of fibre conduit for underground electric conductors, both slip joint and screw joint styles, with bends, elbows, couplings, etc. 6 by 3½ in.; pp. 4. Also, card, with useful tables. The Fibre Conduit Co., Orangeburg, N. Y.

Hoists and Derricks.

Large catalogue, 1903 edition, with descriptions and illustrations of hoisting engines, belt-power, electric, horse-power and hand-power hoists, many kinds of derricks, locomotive cranes, elevators, wire rope and fittings, blocks, winches, and other kinds of contractors' and quarrymen's machinery. 12 by 9 in.; pp. 128. American Hoist & Derrick Co., St. Paul, Minn.

Incandescent Lamps.

Booklet devoted to the merits of the "Sterling Special" incandescent electric lamp, the filament of which is so constructed that it furnishes sixteen candle power of light "all ways always." 6 by 3¼ in.; pp. 11. Sterling Electrical Manufacturing Co., Warren, Ohio.

Irrigation.

Circular devoted to power irrigation, with illustrations and descriptions of the Colorado gasoline engine for pumping water and for other purposes, and of the Deluge centrifugal pump. The Irrigation and Mining Supply Co., Denver, Colo.

Kerosene Engines.

Catalogue A 30, with illustrations and descriptions of Mietz & Weiss gas and kerosene engines, both stationary and portable, for pumping, hoisting, compressing air, generating electric currents and general power purposes. Also, testimonials of users. 6 by 9¼ in.; pp. 24. August Mietz, 126-138 Mott St., New York.

Launches.

Catalogue with illustrations, plans and descriptions of many styles and sizes of Lozier high-grade launches and yachts equipped with gasoline engines. The Lozier Motor Company, Plattsburg, N. Y.

Locomotor Engines.

Large catalogue, illustrating and describing traction engines, hauling engines, road locomotives, and portable engines, for all kinds of work, on all sorts of ground and roads. Also, wagon cars, single or in train, for transporting stone, ore, lumber and general merchandise. 10 by 8 in.; pp. 40. Buffalo Pitts Company, Buffalo.

Machine Tools.

Large pamphlets, devoted, respectively, to horizontal boring, drilling and milling machines and to multiple drills, with half-tone illustrations and descriptions of the finest and most modern examples of machine tools of these classes. 12 by 9 in.; pp. 48. Niles, Bement, Pond Co., 136-138 Liberty St., New York.

Mechanical Stoker.

Large pamphlet, with illustrations and description of the Wilkinson automatic mechanical

stoker, the works where it is manufactured and plants where it is in use, together with many testimonials from users. 12½ by 8 in.; pp. 29. Wilkinson Manufacturing Co., Bridgeport, Pa.

Mond Gas.

Large book, illustrating and describing the Mond producer gas process, with and without the recovery of ammonia, and many applications of this gas for power and other purposes, together with views of plants, diagrams, tables, working figures, etc. 10½ by 8¼ in.; pp. 104. R. D. Wood & Co., Philadelphia.

Narrow-Gauge Railways.

Catalogue No. 77, devoted to portable and industrial railway equipments for hand, steam and electric power, with illustrations and descriptions of rails, track, switches, frogs, turntables, many kinds of cars for a great variety of purposes, and narrow-gauge railway materials of all descriptions, with views of places where these railways are installed. 10 by 8 in.; pp. 80. Arthur Koppel, 66-68 Broad St., New York.

Oil Engine.

Pamphlet, with descriptions and half-tone illustrations of Secor kerosene-oil engines for general power purposes, and particularly as directly connected to electric generators in a self-contained unit, together with a general account of the Secor power system. 9 by 6 in.; pp. 26. The General Power Company, 81-83 Fulton St., New York.

Oiling Devices.

Catalogue, with illustrated descriptions of self-closing, dust-proof, special oil cups for special places, in many styles, and auxiliary oiling devices. 9¼ by 6 in.; pp. 16. Bower Manufacturing Co., Auburn, N. Y.

Pneumatic Hammers.

Pamphlet, with illustrated descriptions of the Haeseler-Ingersoll "axial valve" air hammers for chipping, riveting, scaling, caulking, flue beading and other purposes, and also of other pneumatic tools and apparatus. 9 by 6 in.; pp. 16. Haeseler-Ingersoll Pneumatic Tool Co., 26 Cortlandt St., New York.

Pneumatic Tools.

Circular No. 35, with illustrations and descriptions of pneumatic long-stroke riveting hammers, chipping, caulking and beading hammers, piston air drills, air compressors, pneumatic painting machines, and other kinds of pneumatic machinery. 12 by 9½ in.; pp. 2. Chicago Pneumatic Tool Co., Chicago.

Pumping Machinery.

Special booklet No. 32, with illustrations and descriptions of boiler feed pumps, low service pumps, underwriter fire pumps, artesian engines for operating working barrel in artesian wells, hydraulic pressure pumps, combined gasoline engine and pump, and other kinds of steam and power pumping machinery. 6¼ by 3½ in.; pp. 24. Fairbanks, Morse & Co., Chicago.

Roller Bearings.

Pamphlet, with illustrations and descriptions of Moffett roller bearings for fire apparatus, automobiles, electric motors, electric cars, railway cars, etc. 7 by 9½ in.; pp. 8. Also, a pamphlet containing a report of tests of Moffett roller bearings in comparison with sliding bearings made at the Armour Institute of Technology by Professors C. V. Kerr and A. M. Feldman. 9 by 6 in.; pp. 54. S. B. Thorp, Moffett Roller Bearings, 290 Broadway, New York.

Rolling-Mill Machinery.

Large, cloth-bound book, illustrating and describing steam engines for blast furnaces and power purposes, rolling mills, steam and hydraulic shears, rail-straightening presses, hydraulic presses, steam hammers, and other kinds of blast-furnace, rolling-mill and steel works machinery. 9½ by 12¾ in.; pp. 50. Mackintosh, Hemphill & Co., Pittsburg.

Sawing Machinery.

An "art nouveau" pamphlet, entitled "Instructions on the Erection and Care of Band Sawmills, Band Resaws, Band Saws, etc.." and dedicated to "the sawyers of the world," with illustrations and descriptions of many kinds of wood-sawing machinery. 7 by 5 in.; pp. 24. J. A. Fay & Egan Co., Cincinnati.

Sewer Pipe.

Catalogue, with price lists, descriptions and illustrations of sewer pipe, culvert pipe, water pipe, fire-clay flue linings, fire brick, drain tile, Porter paving brick, and other clay goods, and manhole heads and other castings, together with many items of useful information and discount table. 9 by 6 in.; pp. 62. Arthur N. Pierson & Co., 1 Park Row, New York.

Steam Engines.

A catalogue, with half-tone illustrations and descriptions of the Reeves compound steam engines, of both vertical and horizontal types, with details of the cylinder and valve mechanism, the steam distribution and the adjustable piston valve, together with some information concerning the Reeves automatic single-cylinder engines. 9 by 6 in.; pp. 48. The Reeves Engine Co., 83 Liberty St., New York.

Summer Homes.

Illustrated catalogue, with embossed cover in colors, very beautiful half-tone engravings and full-page plates in tint, and several maps. Issued by the New York, Ontario & Western Railway. Gives concise information concerning every point on or accessible from the main line and branches of the road—its position, elevation, the fare from New York, the fishing and other attractions, and the situation and rates of all hotels and boarding houses. The information is full, accurate, well arranged and well indexed. A handsome and useful publication. 9¼ by 6¼ in.; pp. 166. J. C. Anderson, G. P. A., 56 Beaver St., New York.

Transformers.

Bulletin No. 132, with illustrations and descriptions of S. K. C. large transformers and special transformers and their details. 10½ by 8 in.; pp. 8. Stanley Electric Manufacturing Co., Pittsfield, Mass.

IMPROVED MACHINERY

New Processes and New Appliances

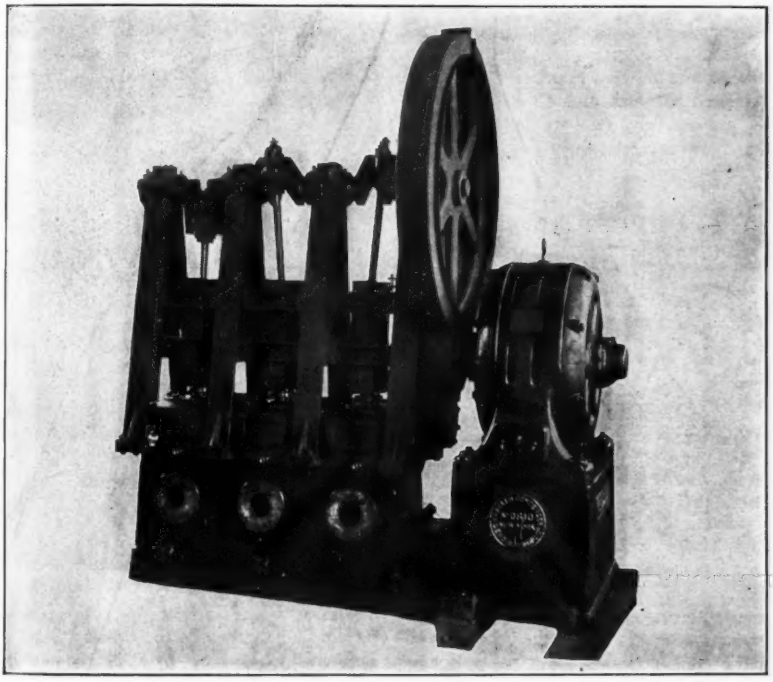
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Edwards Air Pump.

THE Edwards air pump, which has been recently introduced into this country by the Wheeler Condensing & Engineering Co., and is already extensively used, embodies the latest improvements in the design of air-pump machinery.

as called for in steam-turbine practice, since it is a well known fact, demonstrated by experiment, that there is a loss of ¾ inch to 1 inch of vacuum with the ordinary type of pump, due to the vapor tension necessary to lift the suction valves.

The valves in the Edwards pump are



EDWARDS AIR PUMP

This pump is arranged with one set of valves, viz.: the discharge valves, there being no suction or bucket valves used, the absence of the latter making this pump peculiarly adaptable to high vacuums, such readily accessible by hand-hole plates; the pump is single-acting, and the plungers have no packing.

The action of this pump is as follows: The condensed steam flows continuously

by gravity to the base of the pump. The plunger descends, and uncovers the ports, admitting air freely into the cylinder. The conical face of the plunger strikes the water, which is projected without shock through the ports into the cylinder. The plunger then rises, closes the port, sweeping the air and water before it, and discharging them through the valves in the head of the cylinder. By this method, the water is dealt with mechanically, the air having free flow into the cylinder, and its action is in no way dependent upon the pressure in the condenser, and therefore no loss in vacuum is due to the pressure necessary to lift the valves, since none are used.

In the Edwards pump, the speed of the water must correspond to the speed of the bucket, and consequently the pump, having a small and regular quantity of water to deal with at each revolution, is particularly well suited to work at high speeds, such as those commonly adopted for the engines of torpedo boat destroyers and other fast vessels. For the same reason this pump is far less likely to cause trouble should the speed of the engines be suddenly increased, as is the case when "racing" takes place.

Another point of considerable importance in the design of this pump is that clear air inlets are maintained. Under ordinary working conditions, when the bucket descends and the ports open, there is absolutely no obstruction between the condenser and the pump; the air has a perfectly free entrance into the barrel while immediately afterwards the water is injected into the barrel at a high velocity. Thus, instead of obstructing the entrance of the air, the water tends to compress that already in the barrel, and to entrain or carry in more air with it.

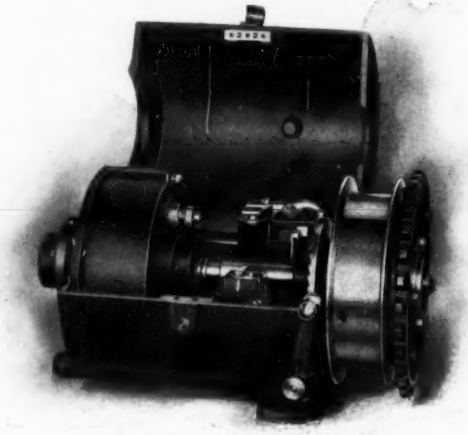
An electrically driven triplex pump of recent design is shown in the accompanying illustration; this pump is geared to a three-phase induction motor, and under test produced a vacuum of 29 inches

Results are constantly obtained with the Edwards pump which approximate very closely to the best theoretically possible, and the high favor in which it is held by engineers is evidenced by its widespread use.

Any further information desired will be cheerfully furnished by the Wheeler Condenser & Engineering Co., of 120 Liberty Street, New York.

The Monarch Engine and Motor Stop System.

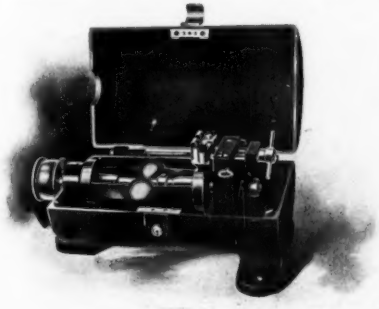
THE greater the size of a power plant, the more important it becomes that it should be made secure against damage of any kind, and whether a plant be large or small, no reasonable precaution should be omitted to remove the possibility of all accidents which may be dangerous to life and property. This proposition is so self-evident that no extended argument is needed to sustain it, and the only problem that remains is to obtain a thoroughly reliable safety system.



MONARCH ENGINE STOP.

Such a safeguard is provided by the Consolidated Engine-Stop Company in their "Monarch" system, in which a number of

automatic devices act together to add to the efficiency and economy of operation of steam and electric plants, and, particularly, to furnish absolute security against accident. This system consists of four units, that is, the engine stop for automatically closing down the engine in cases of emergency; the speed limit for automatically preventing an excessive speed of an engine; the vacuum valve for automatically opening communication between the interior of the condenser and the atmosphere; and the



MONARCH SPEED LIMIT.

circuit breaker trip for automatically tripping the circuit breaker in cases where generators are operated in multiple; each device performing its functions automatically, when the necessity arises, and the whole constituting a system that absolutely insures the safety and integrity of the plant under all operative conditions and at all times.

In addition to the automatic feature of the Monarch system, the engine may be closed down from any part of the building by the mere pressing of a button. These buttons operate the stop through electrical connection and may be located at any convenient points and at as many as may be desired. When an emergency arises the means to stop the engine are ready at hand at the most remote place of factory or shop. Besides, at these times, moments are precious and the stop works instantaneously. The throttle valve is closed in from three to ten seconds after the button has been pushed, quicker by many times than any human hand could work.

The stops are simple in construction and require only ordinary care to maintain them in perfect repair. It is the custom in many plants for the stop to be used daily in "shutting down," and this practice is recommended in order that the stop may have the ordinary care given the rest of the machinery, and thereby insure its being kept in running order at all times.

An electrical gong is connected with the stop and is placed in the engine room. It notifies the engineer in case the stop is brought into action.

Some of the most disastrous accidents occurring throughout the country have been from bursting flywheels due to "runaway" engines, and it is worthy of note that many of these accidents have been in plants using the most modern and expensive machinery. These accidents have cost many lives, and the losses from damage to machinery and plants aggregate an enormous sum.

The speed limit is a device for automatically preventing an excessive speed of the engine. With it the maximum speed can never approach the danger point. The speed limit is directly connected to the main flywheel shaft and can be set to act at any number of revolutions. When the speed of the engine exceeds the desired number of revolutions, no matter from what cause, the speed limit operates the stop automatically by electrical contact, immediately shutting off the steam, and thereby providing absolute surety against "runaways."

The construction of the Monarch speed limit is very simple. The machine is enclosed in an iron case and occupies a space of only 7 by 12 inches. It can be readily applied to any engine. It consists of a pair of governor springs arranged on a horizontal shaft and provided with the usual central balls. When the speed increases beyond the desired point the balls, separating by centrifugal force, move a sliding collar on the shaft to which they are connected until this collar comes in contact with two electrical terminals, thus completing the circuit and putting the stop in operation. As stated, these terminals can be adjusted at will so that the circuit is not closed until the engine reaches any desired speed. The shaft of

this machine is run on ball bearings, requiring but one-quarter of a pound pull to drive it, and is driven by a belt from the main or fly-wheel shaft of the engine, which is guaranteed to sustain a weight or pull of 275 pounds.

For several years the Consolidated Engine-Stop Company have been installing the system just described in many of the biggest plants all over the country where steam is used for power, but the increase in the use of electric motors for power purposes has shown the desirability of a device which will do for the electric motor what the engine stop does for the steam engine.

This want has been met by the Monarch motor stops, an exceedingly practical apparatus, which places an electric motor or a motor-driven machine under absolute control from any part of the works.

Snap switches of the improved dial pattern are placed at different points wherever desired, and one turn of the switch operates a separate battery system which throws the main switch at the board. These switches are always available for immediate use, but are protected from meddlesome and unauthorized employees. The switchboard is an attractive sheet of marble or slate carrying a testing apparatus as well as the main switch. The board itself can be used as a main switchboard or it can be placed in the office or other part of the plant and used only in emergencies. The apparatus can be tested from the switchboard to detect low battery power or short circuits. The system of wiring is patented and is so simple that chances of trouble with it are extremely remote.

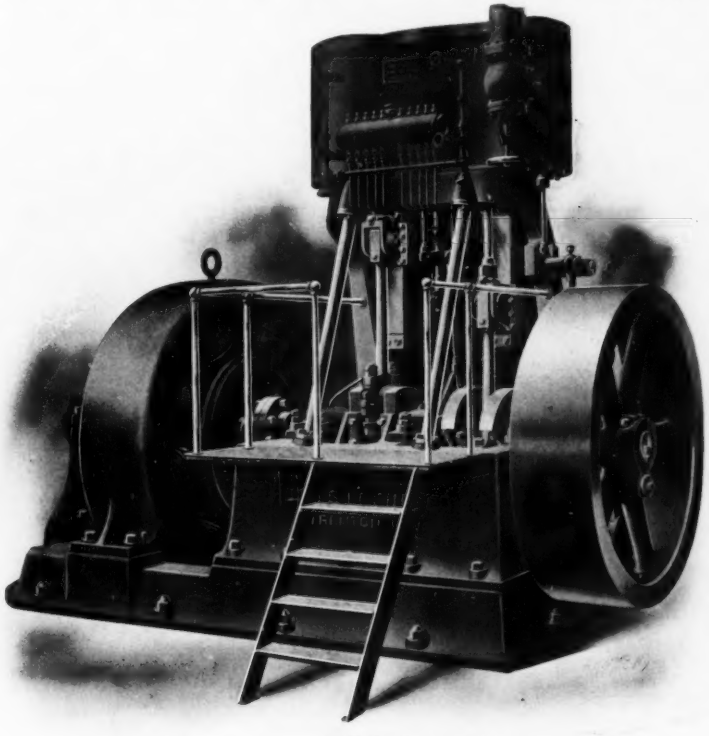
The Monarch motor stop can be connected with any size of motor using any kind of current. It will stop a machine under load in two to five seconds, and can be applied to protect the whole line, or a limited number of motors or a single motor.

This new apparatus gives the company a system of power-control and speed-limiting devices which meets every requirement for electric as well as steam-driven machinery, and any further details or other information which may be desired will be gladly given by the Consolidated Engine-Stop Company, of 100 Broadway, New York.

SWITCHBOARD FOR MONARCH MOTOR STOP.

The Reeves Compound Engine.

IN the present state of steam engineering practice, it takes a remarkably good engine to attract more than passing notice, and it is with a full realization of these conditions that the Reeves Engine Company have developed their steam engines, which are built so that they will not only attract favorable attention, but hold it when they are subjected to the strain of everyday use.



A REEVES VERTICAL COMPOUND STEAM ENGINE DIRECTLY CONNECTED TO A 200-K. W. GENERATOR.

This company constructs automatic single cylinder engines and compound engines. The latter are designed for high and medium speeds, and are of the vertical type for marine use, and of both horizontal and vertical types for stationary work. The steam distribution of these engines gives practically an equal division of work between the high and the low-pressure cylinders, and they are so designed that either cylinder can be used, independently of the other, should necessity require. The engines also work non-condensing very satisfactorily when it may be desirable to run them that way, as in electric lighting and traction work, where there are wide variations in load.

The receiver between the high and low-pressure cylinders is practically eliminated, for the cavities around the main valves, between the cylinders, are filled with high-pressure steam, which prevents any losses from condensation.

In the Reeves engines the clearance in the high-pressure cylinder is generally much

less than in any other well designed high-speed engine; while the clearance in the low-pressure cylinder is very small, and in some cases is but half that of some other types of engines.

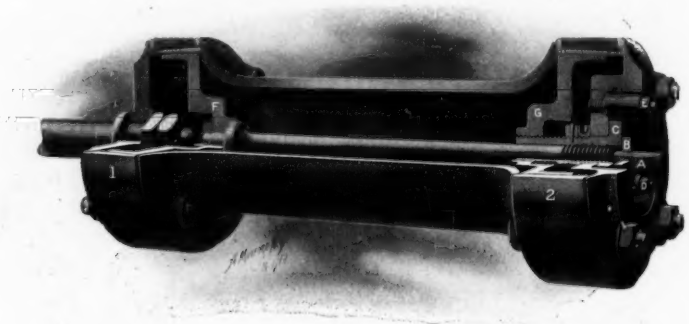
All the Reeves engines are designed to run continuously under their normal rated load, and are always capable of developing in a satisfactory manner greater power when called upon to do so.

The arrangement and design of cylinders and valves gives results that are believed to be unequalled even in compound engines. Great efficiency and economy has been attained without intricacy and multiplicity of parts. Two valves of the piston type are used, the piston valve, on account of the shape of its seat, having the great advantage over the flat slide valve of giving exceedingly large but narrow port openings. This is especially valuable under light loads, as it permits most excellent steam admission and quick cut-off.

This construction also allows of the simplest means for adjustment and compensation for wear. The valves are adjusted at both ends simply by turning an easily accessible screw. The first and smaller of these valves admits steam to the high-pressure cylinder and is controlled by the governor. This valve is perfectly balanced and has no pressure on either end. The governor, therefore, has a very light load and responds instantly, thereby regulating the speed within very narrow limits. The second valve governs the compression in the high and low-pressure cylinders, and admits steam to, and controls the exhaust from, the low-pressure cylinder. It is driven by a fixed eccentric and always gives a predetermined compression in both cylinders. The steam is admitted directly from the high-pressure cylinder through this valve into the low-pressure cylinder No receiver is used and therefore no steam is expanded uselessly. The highest economy is thereby maintained.

The Reeves patent adjustable piston valve is so designed and constructed that it will remain positively locked after adjustment, and it has no rings that can be displaced or injured by the action of the steam. Either end of the valve may be adjusted from the upper end of the valve cavity, and this is done without removing the valve from its seat. Means are provided for securely locking each end separately, and thereby giving the security of a solid plug valve without its obvious disadvantages, and enabling the wear to be taken care of from time to time without any machine work. These valves are very light, requiring little power to move them, and have no parts that can become disarranged or loose.

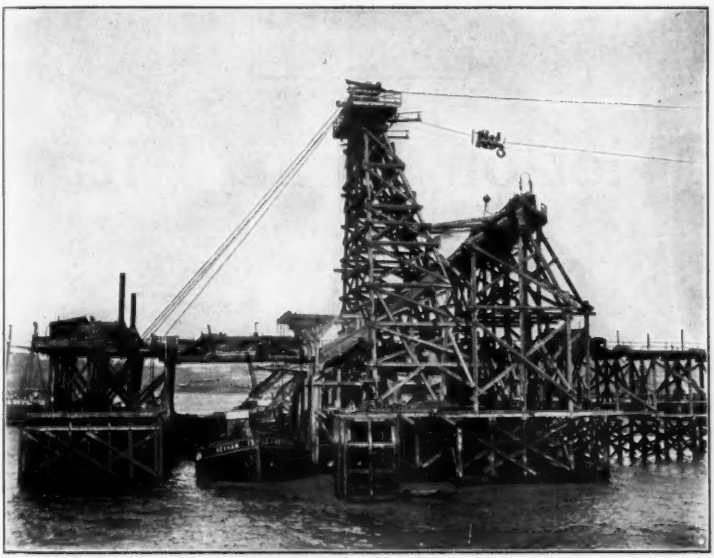
Further details and all other information desired concerning these interesting engines and their performance will be gladly furnished by the Reeves Engine Co., 83 Liberty Street, New York.



THE REEVES PATENTED ADJUSTABLE PISTON VALVE.

Lidgerwood Cableways

For Economical Hoisting and Conveying



Two Lidgerwood Radial Cableways in use by Sir John Jackson, Ltd., (of London) at Keyham Admiralty Dock Yards, England.

Cableways span 1,500 feet; load 6 tons. Illustration shows head towers for both cableways. Loads dump into barge. Both tail towers travelling.

Send for new Illustrated book "The Lidgerwood Cableway."

Lidgerwood Mfg. Co.

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gives adequate protection to rolling stock — its capacity exceeds the tractive effort of two powerful locomotives. By its use injury to draft rigging is reduced to a minimum

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